PEARL

The Journal of HEREDITY

EXTREMES OF PIGMENTATION IN TWINS

(SEE PAGE 23)

A Mosaic Fowl
Selective Fertilization
Breeding New Sweet Potatoes
Nematode-Resistance in Pineapples
Three Generations of Clubbed Fingers
Seeds versus Spores as Species-Distributors

VOLUME 26 JANUARY, 1935 NUMBER 1

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

DAVID FAIRCHILD, President Vice-President, W. E. CASTLE Secretary, C. E. LEIGHTY

Treasurer, J. H. KEMPTON

Legal Advisors, PEELLE, OGILBY and LESH

EDITORIAL BOARD

Managing Editor, ROBERT C. COOK

M. DEMEREC R. R. GRAVES L. C. DUNN

H. J. MULLER GEORGE M. DARROW PAUL POPENOE

Members of the Council are ex-officio members of the Executive Board

COUNCIL

W. E. CASTLE, Professor of Genetics, Harvard University, and Research Associate of the Carnegie Institution of Washington.

LEON J. COLE, Professor of Genetics, University of Wisconsin.

G. N. COLLINS, Botanist, U. S. Department of Agriculture, Washington, D. C.

O. F. COOK, Bionomist in Charge of Breeding Investigations, U. S. Department of Agriculture.

DAVID FAIRCHILD, Agricultural Explorer, U. S. Department of Agriculture.

HARRY V. HARLAN, Senior Agronomist in Charge of Barley Investigations, U. S. Department of Agriculture.

SAMUEL J. HOLMES, Professor of Zoology, University of California, Berkeley, California.

C. E. LEIGHTY, Agronomist in Charge of Dry Land Agriculture, U. S. Department of Agriculture.

N. D. C. LEWIS, Chief Medical Officer, St. Elizabeth's Hospital, Washington, D. C.

J. H. KEMPTON, Bureau of Plant Industry, U. S. Department of Agriculture.

E. W. SHEETS, Chief of Animal Husbandry Division, U. S. Department of Agriculture.

SEWALL WRIGHT, Professor of Zoology, University of Chicago.

ADVISORY COMMITTEE

W. S. ANDERSON, Genetics Department, University of Kentucky, Lexington, Kentucky.

E. B. BABCOCK, Genetics Department, University of California, Berkeley, California.

E. A. BESSEY, Professor of Botany, Michigan State College, East Lansing, Michigan.

A. F. BLAKESLEE, Plant Genetist, Carnegie Institution, Cold Spring Harbor, New York.

J. K. BREITENBECHER, McGill University, Montreal, Canada.

W. E. BRYAN, Professor of Plant Breeding, University of Arizona, Tucson, Arizona.

C. B. DAVENPORT, Director, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, L. I., New York.

J. A. DETLEFSEN, Professor of Genetics, Wistar Institute, Philadelphia, Pennsylvania.

RUSSELL W. DUCK, Livestock Editor, *The Rural New Yorker*, Syracuse, N. Y.

E. M. EAST, Professor of Plant Genetics, Bussey Institute of Applied Biology, Boston, Mass.

R. A. EMERSON, Professor of Plant Breeding, Cornell University, Ithaca, New York.

C. P. GILLETTE, President, The Genetic Foundation, Fort Collins, Colorado.

C. M. GOETHE, Sacramento, California.

HARRISON R. HUNT, Professor of Zoology, Michigan State College, East Lansing.

H. S. JENNINGS, Professor of Zoology, Johns Hopkins University, Baltimore, Maryland.

D. F. JONES, Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.

M. A. JULL, Senior Poultry Husbandman, U. S. Department of Agriculture, Washington, D. C.

F. B. LINFIELD, Director, Montana Experiment Station, Bozeman, Montana.

C. C. LITTLE, Director, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

JAY L. LUSH, Professor in Animal Husbandry, Iowa State College, Ames, Iowa.

H. H. Newman, Professor of Zoology, University of Chicago, Chicago, Ill.

T. S. PALMER, Expert in Game Conservation, U. S. Dept. of Agriculture, Washington, D. C.

JOHN H. PARKER, Professor of Agronomy, Kansas State College, Manhattan, Kansas.

JOHN W. SCOTT, Professor of Zoology, University of Wyoming, Laramie, Wyoming.

A. D. SHAMEL, Physiologist, U. S. Department of Agriculture, Riverside, California.

GEORGE H. SHULL, Professor of Biology, Princeton University, Princeton, New Jersey.

EDMUND W. SINNOTT, Professor of Zoology, Barnard College, Columbia University, New York City. (Representative of A. G. A. on Council of Amer. Assoc. for the Advancement of Science.)

W. W. SMITH, Professor of Animal Husbandry, Purdue University, Lafayette, Indiana.

CHARLES R. STOCKARD, Professor of Anatomy, Cornell University, New York City.

A. B. STOUT, Director of Laboratories, New York Botanical Gardens, New York City.

W. T. SWINGLE, Plant Physiologist in Charge of Breeding Investigations, U. S. Department of Agriculture, Washington, D. C.

W. H. TOMHAVE, American Aberdeen-Angus Breeders' Association, Chicago, Ill.

H. E. WALTER, Professor of Biology, Brown University, Providence, Rhode Island.

H. J. WEBBER, Prof. Subtropical Hort., Citrus Experiment Station, Riverside, California.

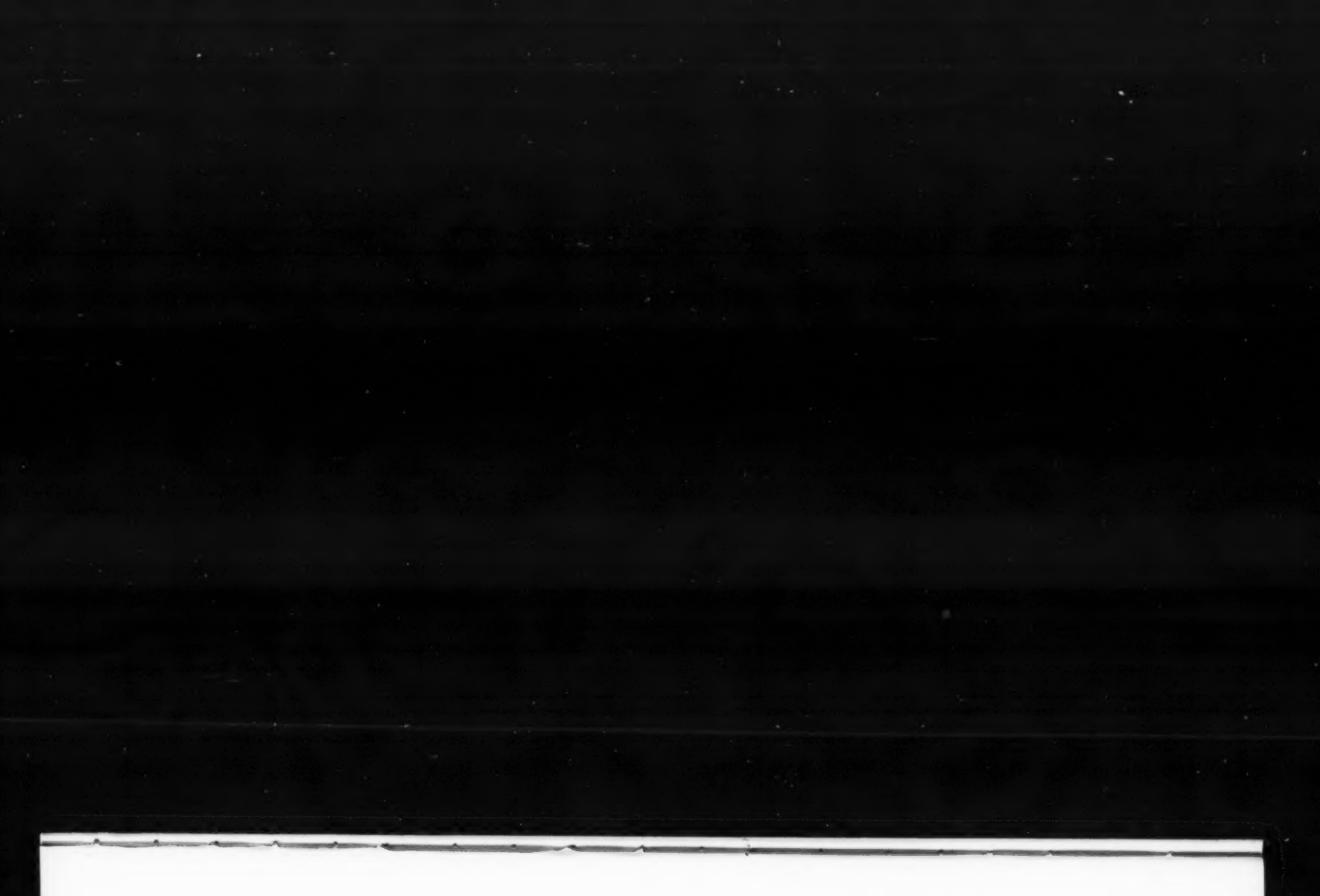
E. N. WENTWORTH, Armour's Bureau of Agr'l Research and Economics, Chicago, Illinois.

P. W. WHITING, Station for Experimental Evolution, Cold Spring Harbor, Long Island, N. Y.

The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION at 1918-32 Harford Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters to Room 510, Victor Building, Washington, D. C. Communications regarding the business management of The JOURNAL OF HEREDITY may be addressed to the publication office, 1918-32 Harford Avenue, Baltimore, Md., or to the Victor Building, Washington, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in section 1103, Act of October 3, 1917, authorized December 20, 1918.

Contents copyrighted 1935 by the American Genetic Association. Unauthorized reproduction of material from THE JOURNAL not permitted. The title "Journal of Heredity" is registered as a trade-mark in the U. S. Patent Office.

$3.50 a Year, 35c the Copy. Price of back numbers on application.



THE JOURNAL OF HEREDITY

AN ILLUSTRATED MONTHLY PUBLICATION DEVOTED TO PLANT BREEDING, ANIMAL BREEDING AND EUGENICS

PUBLISHED BY THE
AMERICAN GENETIC ASSOCIATION
WASHINGTON, D. C.

VOLUME XXVI

WASHINGTON, D. C
1935

Copyright 1935

by

AMERICAN GENETIC ASSOCIATION

The

Journal of Heredity

Vol. XXVI JANUARY, 1935 No. 1

CONTENTS

Breeding and Selection of Sweet Potatoes
By M. G. Tioutine 3

A Brahma-Plymouth Rock Mosaic
By E. Roberts and J. H. Quisenberry 11

Clubbing of the Fingers Inherited
By J. Thornwell Witherspoon 15

Selective Fertilization
By P. W. Whiting 17

Three Generations of Albinism and Twinning
By Ernest Windle 23

A Faceless Lamb
By L. M. Winters and M. C. H. Kernkamp 33

Studies on Varietal Resistance of Pineapple Plants
By H. R. Hagan and J. L. Collins 35

REVIEWS AND NOTES

Eugenics of All Nations 10
Peony Twins 14
Just What is a European? 22
Man in Prehistory 24
How Shall We Know Plants? 25
Books Received 31

STUDENT SUBSCRIPTIONS

A Special Rate to Classes in Genetics or Biology

Members engaged in teaching genetics or related subjects are cordially invited to use the Journal as a supplementary text in their classes. The rapid progress of the science, after being so long neglected, is one of the most important and attractive features to place before students. Even the latest textbooks are soon outdated, but they become more interesting as the historical background of the discoveries described in the Journal of Heredity.

Student subscriptions covering the academic year of eight months, in groups of ten or more, may be ordered by members at one dollar ($1.00) each, four months for 50 cents. These special rates to students will be accepted only when applied for by members of the Association, in whose classes the Journals are to be used. The *student subscriptions* will be sent in bulk to the member in whose name they are ordered.

Special Trial Offer to Members of A. G. A.

Members engaged in teaching will be supplied free up to twelve copies of two issues for classroom use. Try the Journal for two months at no expense and under no obligation to continue. Issues for this purpose will be sent in bulk to members applying for them. Send orders to the American Genetic Association.
510 Victor Building Washington, D. C.

SWEET POTATOES IN FLOWER

Frontispiece

While the sweet potato is an important crop in the warmer temperate regions it can only be propagated vegetatively because flowering is extremely rare. The breeding and selection of sweet potatoes is therefore limited to those regions where a combination of climate and soil favor the production of flowers and seed. At Sukhum in the Russian Trans-Caucasus many varieties from such widely separated regions as Java, Formosa, and the United States produce abundant crops of seed. This view in the sweet potato hybridization plat of the Subtropical Institute shows flowers on two sweet potato plants and bags covering flowers which have been artificially pollinated.

BREEDING AND SELECTION OF SWEET POTATOES

M. G. TIOUTINE

Research Institute of Subtropical Cultures, Sukhum, USSR

IN most parts of the temperate zone, even in regions where it is an important crop plant, the sweet potato rarely flowers. The abundant flowering of certain varieties of sweet potatoes at Sukhum has made it possible to carry on there extensive experiments looking to the production of new varieties of horticultural value. The extremely favorable complex of a suitable soil and a subtropical climate has been an important factor. Also the work has had as its basis the observation that certain varieties did produce flowers and fruits under these conditions. The work has been based largely on Formosan varieties which flower abundantly during the long summer, the first blooms appearing in July, with flowering extending until frost early in December. In September, 1933, the American variety Southern Queen also flowered and this was crossed with other varieties in order to produce forms resistant to fusarium disease and with improved flavor. In October and November, 1933, the seed from these crosses was harvested.

In 1932 thirty of the seedling sweet potatoes produced by our breeding flowered in our trial plots in the neighborhood of Sukhum. The plants set out in sandy soil began to flower in the long summer drought and many kinds gave a considerable quantity of mature seed. The most abundant flowering and fruiting was observed in three selections (Nos. 25, 89, and 159). These flowered both in light and in heavy soil. Flowering was also observed in seedlings from Hawaiian and from Bermuda varieties and in some varieties obtained from Java.

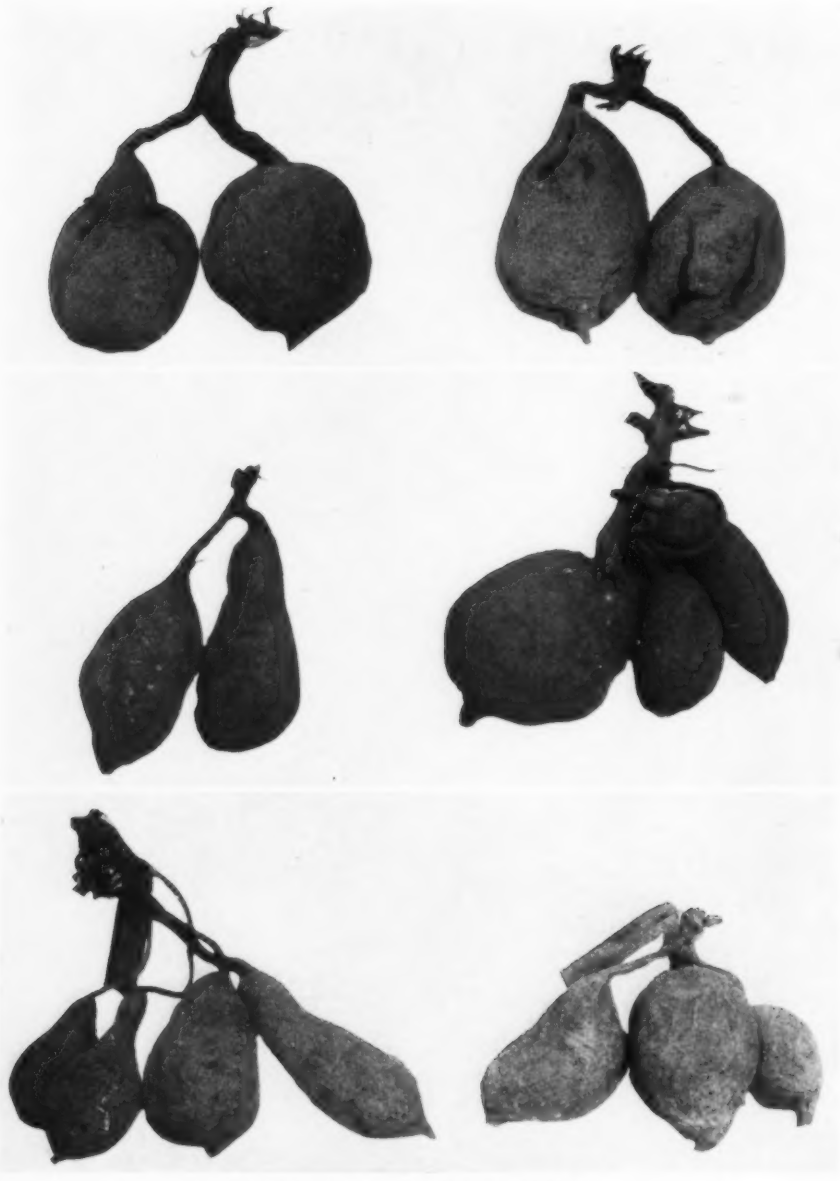
Considerable effort was made to induce flowers in those varieties, both of our breeding and of American origin, which did not flower naturally. Success was not attained either by restricting the root systems, grafting on other species of Ipomea, or by growing as perennial cultures under glass. It is quite certain that the ability to produce flowers and seed is a varietal characteristic in this species. The progeny of the three above mentioned freely flowering crosses showed as free a flowering habit as the parent forms. In other varieties the capacity for sexual reproduction is so greatly reduced that flowers occur only in the tropics or possibly they may be induced in these varieties by exposure of the plants to an extremely long daily photoperiod.

During 1932 and 1933 nearly fourteen thousand crosses of various varieties of the sweet potato were made at this station. The object was to attempt to produce new varieties having superior horticultural characteristics and the qualities selected for were taste, yield, shape, and keeping quality. From these crosses many thousands of hybrid seed were harvested and from these a large number of hybrid tubers has been obtained. A study of the field characteristics of the first generation hybrids is under way.

Pollination of the Sweet Potato

The sweet potato (*Ipomoea batatas*) belongs to the morning-glory family, the Convolvulaceae. The flowers closely resemble those of the morning-glory and are ordinarily cross pollinated, — the principal agent of pollination being the bee. In nature self pollination is quite a rare phenomenon. In 1933 the author found that it was possible to produce viable seed by self pollination and this technique offers some promise in further breeding work in that it may be possible to create new homozygous forms with constant characteristics of great value. These may prove very useful in themselves or in intercrossing to produce

combination of climate and soil favor the production of flowers and seed. At Sukhum in the Russian Trans-Caucasus many varieties from such widely separated regions as Java, Formosa, and the United States produce abundant crops of seed. This view in the sweet potato hybridization plat of the Subtropical Institute shows flowers on two sweet potato plants and bags covering flowers which have been artificially pollinated.



PROMISING TUBERS OF HYBRIDS

Figure 1

The plants were compared in vigor and habit of growth as well as in the type of tuber they produced. The shape and position of the tuber was also considered. The tubers shown here are from the plants standing highest in all three criteria. (See Table II).

VARIATION IN TUBER FORM
Figure 2

The author displaying tubers produced by two of the hybrid sweet potatoes. Note the differences in form of tuber and in manner of attachment to the stem. This view is taken in the sweet potato breeding plat, and each stake represents the locus of a seedling plant produced by controlled pollination.

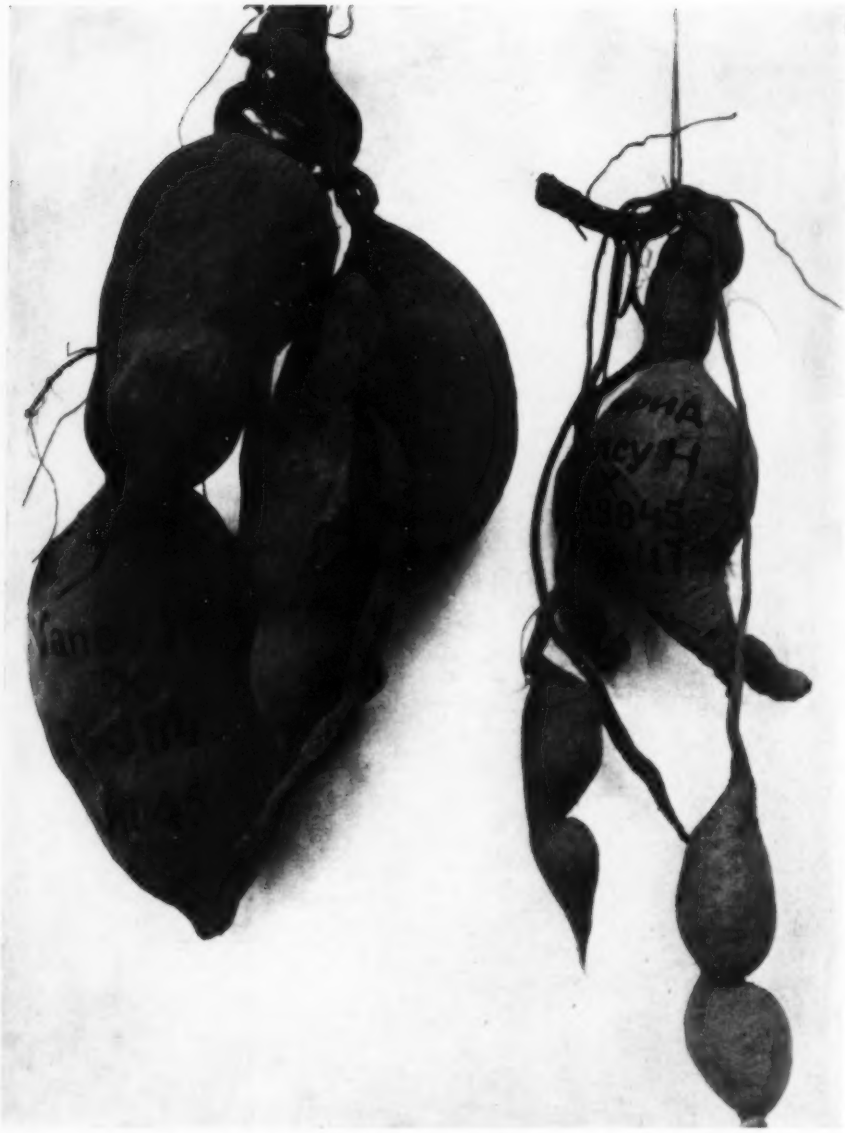
varieties showing unusual vigor or other desirable characteristics. In our trials with artificial pollination 320 flowers were treated with their own pollen and in four cases seeds were obtained, indicating that self-fertility is the exception rather than the rule in this species.

The color of the calyx varies in different varieties from light to dark green, sometimes with a reddish tint. It may be pubescent or glabrous. The five petals of the corolla are united into a funnel shaped flower. The interior of the flower is of the same tint but more intense. The stamens, five in number, are attached to the base of the corolla in a ring around the pistil. The anthers either touch the pistil, or in some varieties with short stamens, they may be shorter than the pistil. The stigma is many headed, white or pale yellow in color. The style is white and thin; the upper part of the ovary is ordinarily orange tinted, sometimes pale yellow.

The buds commonly begin to expand in the evening and open between six and seven o'clock the following morning, or on cool days a little later. In the hottest part of the day the corolla commonly closes. Ordinarily about ten days elapse between the appearance of the bud and the opening of the corolla. Flowering begins toward the basal end of the stem and continues for a month or more, new flowers opening each day.

In the evening of the day they open the flowers begin to wilt and on the following day, or the day after, the flowers fall from the vine. On a single vine as many as ninety to a hundred buds appear, or a total of some three hundred on a single plant. The buds are grouped in clusters of from five to eleven. In each bud the stamens are all usually of the same length and are arranged concentrically around the pistil.

Splitting of the anthers occurs in the bud about a half day before the flower opens, but the pollen is not shed until the corolla is fully expanded. Two hours after the flowers are open the anthers begin to wither. By evening the pistil has also begun to turn a dark color and to die. The pistil is mature by the time the corolla opens and is suitable for pollination at once. The fruits require about six to eight weeks to open and are ready for harvesting in September and October. The fruit of the sweet potato is a four-celled, dry, globular capsule, diameter about six milimeters, and light brown in color. Ordinarily a capsule contains one to two seeds, occasionally three, and very rarely four. The seeds are small, black, sometimes of a fawn colored tint. They measure 3.5 to 4.5



VARIED GROWTH HABITS OF HAWAIIAN HYBRIDS

Figure 3

Root systems of two seedlings of a cross of the Nancy Hall variety with a strain (3845) originated at the Hawaiian Experiment Station. Of fifty-one seedlings from this cross, one produced a desirable form of tuber (left). The rest produced tubers of a great variety of shapes and arrangements but of no particular promise and the thirty-six remaining seedlings produced no tubers at all. This extreme variability suggests that the material offers great promise to the plant breeder. Among these varied forms there will probably be some of outstanding merit, and these can be propagated vegetatively.

mm. in diameter and are irregularly angular in form.

Methods of Hybridization

The technique of hybridization is not difficult. Three or four hours before sunset buds are selected which will open the following morning. These are emasculated with pincers and covered with a parchment bag closed with a layer of wadding around the base. At the same time the buds to be used for obtaining pollen are bagged to avoid contamination. The pollinations are performed the following morning between six and nine o'clock. The pollen is rubbed on the stigma by direct contact with an anther from the flower chosen as the male parent. After this the flowers are labelled and bagged immediately. Ordinarily ten flowers are treated on each plant. The results of one of our most distinctive crosses are given in Table I. Here about six thousand flowers were hand pollinated with about thirty per cent success. Little difference was observed in the percentages obtained with direct and with reciprocal crosses. In other combinations varying degrees of success were obtained depending upon the degree of compatibility of the varieties crossed and doubtless on other factors.

Most of the capsules contain only one or two seeds. About one in thirty has three seeds and complete fertilization with four seeds was detected only two or three times per thousand flowers pollinated.

The seeds obtained in the fall of 1932 were sown in March, 1933, in the hot house in flats filled with sand. After the cotyledons appeared, the tiny seedlings were picked out by hand and set in small pots in hotbed soil. When hybrid seedlings had obtained a height of ten to fifteen centimeters they were set out in May in the ground. The tubers were harvested early in November.

As is to be expected in a form which is normally asexually propagated, the plants produced by a cross between two varieties are a variable lot. In Table II are given data on 25 plants taken at random, in the order in which they were assigned serial numbers as seedlings, and of the five plants of this series which had outstanding characteristics. Of this array, ten seedlings showed considerable promise in yield, quality, or in other desirable characteristics. They will be studied further for keeping qualities, chemical composition, and so forth. It should be noted in this cross, and it is true in many of the others, that a great number of the seedlings have a coarse habit of growth, tubers of poor shape, or other very undesirable characteristics. About fourteen per cent of the seedlings bore only thin roots and no tubers whatever. In 1934 a much more rigorous selection of promising plants which have been retained will be carried out.

Some of the seedlings are noticeably superior to the parent forms in one or more characteristics. It is quite possible that after they have been propagated vegetatively some of these will show real promise as new varieties. There is no doubt that some of the seedlings gave definite evidence of hybrid vigor as the plants were of remarkably large size, having long and thick vines, large leaves and very large tubers, weighing three kilograms and more.

Hawaiian Hybrids

In 1932 the Institute received from the Hawaiian Experiment Station at Honolulu seeds of three sweet potato hy-

TABLE I—Number of Formed and Harvested Capsules

Names			Number crossed	Total fruits produced	in %	with 1 seed	in %	with 2 seeds	in %	with 3 seeds	in %	with 4 seeds	in %	Total of capsules with seeds	in %	Capsules without seeds	in %
FN89	×	FN25	4,632	1,575	34.0	603	38.2	303	19.2	52	3.3	5	0.3	963	61.1	612	38.9
FN25	×	FN89	2,041	557	27.29	199	35.7	86	15.4	19	3.4	1	0.2	305	54.7	252	45.3

brids, Nancy Hall × No. 3845; Kala × Naleimaile; Southern Queen × Naleimaile. One seedling of the Nancy Hall hybrid has shown a desirable shape of tuber, high yield, and other valuable characteristics. The other fifteen seedlings showed much variability in yield but were of no particular promise. Thirty-six other seedlings of this cross did not form tubers at all or gave only small or irregularly shaped tubers.

Out of twenty-four seedlings from the second hybrid (Kala × Naleimaile), five formed no tubers, eight gave a yield of tubers ranging from .33—2.75 kilograms and the remaining eleven formed small or snakelike tubers. Seven plants out of thirty-one from the Southern Queen cross gave no tubers and the remaining plants showed a yield of from .26-1.25 kilograms per plant. Four plants showed some promise. In 1933 the initial vegetative propagation of the hybrids was effected, and some of them show considerable promise.

Interspecies Hybrids

Hybrids between the sweet potato and other tuberous species of Ipomoea have not only a theoretical interest but alsc may be of no little practical value. One important consideration is the possibility of obtaining frost resistant hybrids that may be wintered in temperate regions in the open ground and that at the same time may have value as a crop. It is known, for instance that tubers of *Ipomoea pandurata* may be stored quite well during the winter in the soil and that they have better keeping quality than the white potatoes. Their flavor resembles that of the Jerusalem Artichoke (*Helianthus tuberosum*). The writer has begun research along this line and pre-

TABLE II—Yield and other valuable characteristics of the hybrid progeny of variety 25 × 89. A total of 120 hybrid plants were grown. This sample shows the characteristics of a random selection, and of the five best plants produced by the cross (Nos. 27, 40, 49, 58, 81, shown in Figure 1).

No.	NN of the hybrid seedling	Quantity of tubers on one plant	Yield in kilograms	Equalization of tubers on the plant (Evaluation on a 5-point scale)	Disposition of tubers	Shape of tubers
1	1	3	0.100	2	1	3
2	2	2	0.15	2	4	3
3	3	2	0.64	1	4	1
4	4	3	2.53	3	4	4
5	5	1	0.50	1	–	2
6	6	1	2.20	1	–	4
7	7	3	0.43	1	2	2
8	8	1	0.75	1	–	3
9	9	2	0.35	1	4	2
10	10	1	0.20	1	–	1
11	11	2	0.80	3	2	3
12	12	1	1.05	1	–	4
13	13	roots	0.0	1	1	1
14	14	2	0.20	2	3	1
15	15	1	1.0	1	–	4
16	16	3	0.20	1	2	1
17	17	1	0.15	1	–	1
18	18	1	0.40	1	–	3
19	19	2	0.100	1	3	2
20	20	2	0.18	1	2	1
21	21	roots	0.0	1	1	1
22	22	3	0.68	1	2	1
23	23	2	1.0	2	5	4
24	24	6	1.25	4	3	3
25	26	1	0.33	1	–	1
27	28	2	1.950	5	4	4
40	43	4	0.98	5	4	5
49	52	2	0.7	4	5	4
58	61	–	1.53	3	5	4
81	85	3	1.25	4	5	4

liminary data are presented here. These experiments were undertaken, both because of an interest in the possibilities of these hybrids and for the light that they might throw on the problem of origin of the cultivated sweet potato.

At Sukhum four species of tuberous Ipomoea are growing at the present time: *I. pandurata, I. macrorhyza, I. fastigiata, I. mammosa.* Two of these species have been suggested as possibly having been the parent form of the sweet potato. Partisans of a New World origin of *Ipomoea batatas* hold that *I. fastigiata* may be the parent form. This species is indigenous in tropical America. Its tubers are edible, and in Jamaica it is called the "wild potato," in Martinique and Guadeloupe the "wild sweet potato." It is a climbing plant with flowers and leaves very much like the sweet potato. Seeds obtained from Puerto Rico were sown at Sukhum in 1932. The seedlings were quite uniform in botanical characteristics. None of them has produced tubers. Some of the seedlings flowered abundantly from the beginning of September to frost.

Proponents of an Old World origin of the sweet potato hold that it may have originated from *I. mammosa,* a native of Abouana, and cultivated to a certain extent in Indo-China. Seeds obtained from Java were sown in 1933, but no flowers have yet been produced. The tubers of *I. mammosa* are almost pear shaped, of a brownish light yellow color with a slightly scaly surface.

In 1932 and 1933 the writer effectuated at Sukhum crossings of *I. batatas*

TABLE III—Yield and description of hybrids of Nancy Hall × 3845.

No.	No. of hybrid seedlings	Yield in kilograms	Observations
1	4	0.53	Deep disposition of tubers in the soil. Figure 2.
2	6	0.90	
3	8	0.50	
4	10	2.00	High equalization and crowded disposition of tubers. Figure 2.
5	13	0.50	
6	17	1.2	Tubers of cultural oval shape.
7	20	0.5	Coarse habitus.
8	21	0.9	
9	30	0.49	
10	31	0.25	
11	33	3.70	
12	37	0.6	
13	45	1.40	Crowded disposition of tubers.
14	46	0.8	Globular shape.
15	47	—	Noncompact disposition of tubers.
16	50	0.5	Excellent shape of tubers.

TABLE IV—Summary of Ipomoea species crosses made and attempted in 1932-33.

Date of crossing	Denomination of the crossed species	Quantity of crossings	Quantity of developed capsules	Percentage of success
September 26-October 15, 1932	I. batatas × I. fastigiata	300	12	4
"	I. batatas × I. pandurata	11	0	0
"	I. batatas × I. macrorhyza	154	1	0.63
September 25, 1933	I. batatas × I. macrorhyza	100	0	0
"	I. batatas × I. pandurata	100	2	2

with *I. pandurata, I. macrorhyza,* and *I. fastigiata.* The results of these hybridizations are shown in Table IV.

In 1932 we had no opportunity to obtain mature seeds because of frosts early in November. In 1933 we were able to harvest quite mature seeds.

From these preliminary data it appears that interspecies hybrids of *I. batatas* and other species of tuberous Ipomoea may quite possibly be obtained. It appears also that the generic relationship between *I. batatas* and *I. fastigiata* is closer than that of the other species of Ipomoea.

In 1934 the writer intends to carry out this research work on the production of interspecies hybrids along more extensive lines and hopes to obtain more decisive results.

◆

Eugenics of All Nations

AN account of the eleventh Assembly of the International Federation of Eugenic Organizations in *Nature* (September 15, 1934) gives some items which may be of interest to the readers of the JOURNAL.

Prof. R. J. A. Berry gave an account of his long researches, and submitted the theory that mental defect can best be described as failure of development of the central nervous system; a condition which as such passes by indistinguishable grades from a pre-embryonic type in brain and cortex development to something which can best be characterized as less than the highest development known. He finds somatic and functional characters corresponding biologically to the various grades of lack of neural development.

Dr. Steggerda and Prof. Rodenwaldt stated that there can be no doubt of wide racial differences in mental faculty. For example, the music tests satisfactory for Europeans would fail altogether to elicit the much finer discrimination common in yellow races and Negroes.

Prof. Freiher von Verschuer showed a chart from a study not yet published dealing with the differentiation of identical and non-identical twins. This chart showed the unreliability of judging from the chorion. In 52 cases with double chorea, 12 proved to be identical and 40 non-identical.

Dr. Ruttke, directing popular education in protection of heredity in Germany, gave a clear outline of the whole policy, which may be briefly summarized as: (*a*) Unification of State control throughout the nation. (*b*) Removal of unemployment (shown to have disintegrating effects on the sense of parental responsibility and family life). (*c*) De-urbanization, which removes large families with self-supporting parents and good family history to peasant holdings which will be entailed. (*d*) Revision of marriage laws, making marriages for social or economic ends liable to be annulled. (*e*) Creation of bureaux for advice on heredity and marriage. (*f*) Provision of loans for young persons of sound stock who desire to marry—a measure which goes hand in hand with the exclusion of women from those industries which can be served by unemployed men. (*g*) The sterilization law. Dr. Ruttke explained that the exclusion of criminals from the operation of this last measure is in order to remove any sense of degradation being connected with the operation; both in the courts and by popular propaganda, the ideal is put forward which has made sterilization successful in California, that the citizen who accepts the operation with a sense of responsibility for posterity merits the esteem of the community. In regard to compulsion, he stated the fact not so widely known that patients may accept institutional treatment of segregation if they prefer it to sterilization.

Reports of growing work and increasing interest were given from every country represented. These will be published in full in the report which will appear in the autumn, and will be obtainable from the Secretariat, price 2*s*. 6*d*.

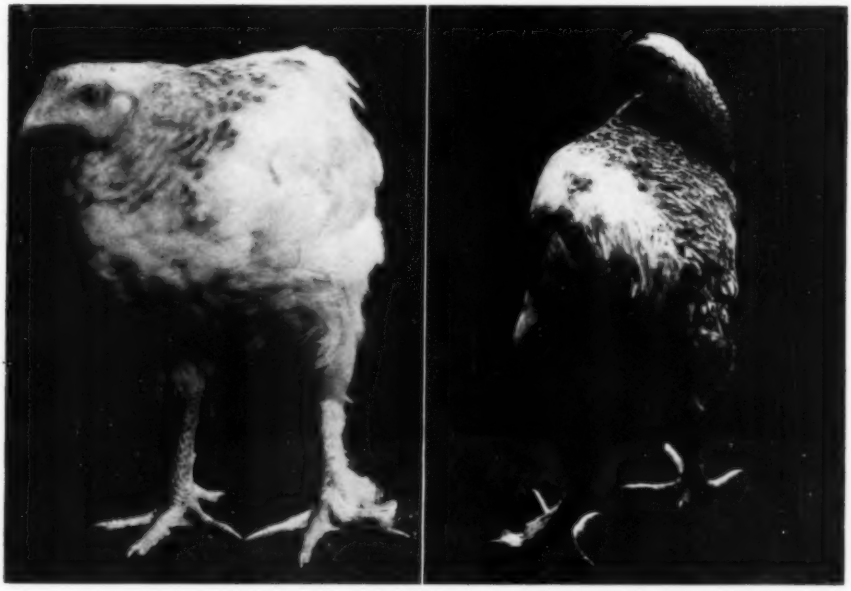
◆

GENETIC GLOSSARY DELAYED

The genetic and technical terms carried in the glossaries during the past three years have been brought together in a separate booklet. Each member of the A. G. A. is entitled to a copy of this on application (additional copies 35c). It was expected that it would be ready for distribution by January 15, but revision and additions have required more time, and the booklet will not issue until about a month later. Members who have requested a copy when paying their 1935 dues, and others who request it in the meantime, will be sent a copy as soon as it is printed. The editors regret the delay.

A BRAHMA-PLYMOUTH ROCK MOSAIC

E. ROBERTS and J. H. QUISENBERRY*



BRAHMA ON ONE SIDE—PLYMOUTH ROCK ON THE OTHER

Figure 4

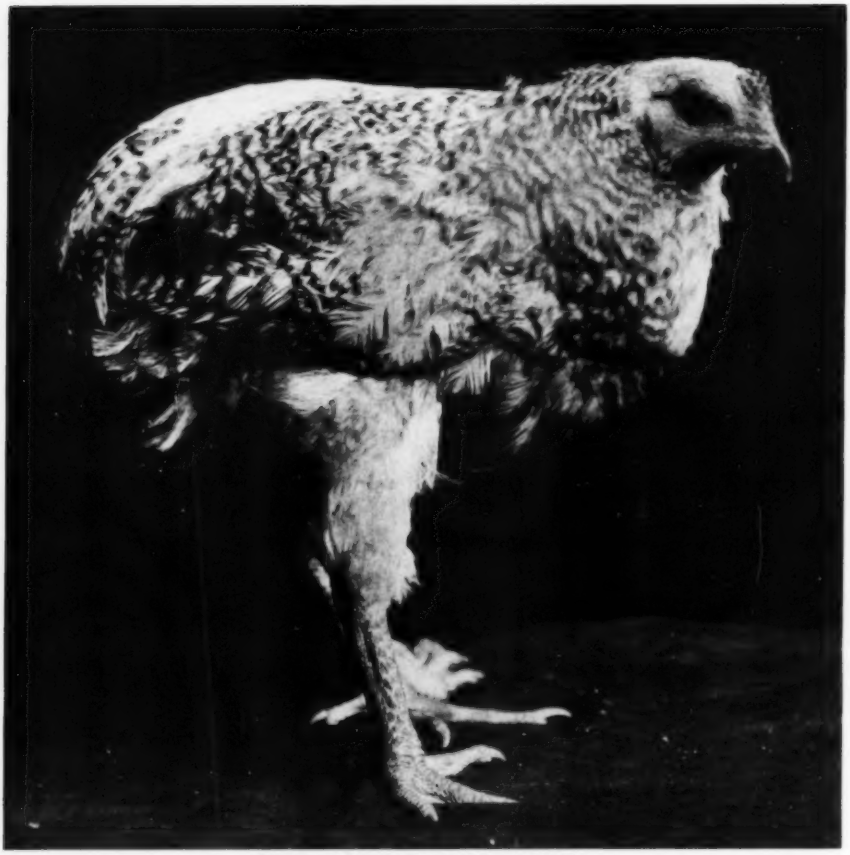
The mother of this fowl was a Barred Rock and the father probably a light Brahma cock. The offspring takes after both parents, the right side being Barred Rock, and the left Brahma. Six cases of mosaic fowls have previously been reported. In only two of these have the two sides differed in more than one characteristic. This bird is to be classified in the latter group as at least three differences are apparent in the two sides, perhaps more.

IN 1932 Crew reported a case of lateral asymmetry in the domestic fowl and discussed this together with the other six cases previously reported.[2] These seven cases are as follows:

1. The two sides different in epidermal pigmentation, body size, bones of right side larger than those of left, and with right testis and left ovotestis.[5]
2. Left half with white skin and right with yellow, and bones on left larger than those on right.[1]
3. Left half of body with white skin and right half with yellow.[4]
4. Same as in 3.[3]
5. Right shank green, left shank yellow.[3]
6. One shank entirely white, the other white with a yellow streak.[3]
7. Right shank white, left shank yellow.[3]

The present case is one in which the right side has the general appearance of the Barred Plymouth Rock and the left side the characteristics of the Light Brahma. The right shank is clean while the left shank is feathered. Barring is extended over the entire right side while it is confined on the left side to the re-

*Contribution Number 49 from the Division of Animal Genetics, Department of Animal Husbandry, University of Illinois.



THE PLYMOUTH ROCK SIDE
Figure 5

Right side of mosaic showing the clean shank and Barred Rock plumage. At least three explanations have been advanced to account for mosaics in the fowl: (1) loss in the cells constituting one half of a whole chromosome or a chromosome fragment; (2) gene mutation in an early cell division affecting one half the animal; (3) and non-disjunction of chromosomes.

stricted pigmented areas on the neck, wing, and tail feathers. Also, the left side of the body is much larger than the right, as is clearly shown in the accompanying figures. The left side continued to grow faster than did the right until the body was asymmetrical in shape, with the head and tail thrown to the right, and the left leg apparently longer than the right. The bird, in external characters a male, was kindly sent to us by C. W. Edmonston, Rector, Arkansas, after Mr. F. L. Platt, of the *American Poultry Journal*, had brought it to our attention. He had both Barred Plymouth Rock and Brahma males, but only Barred Playmouth Rock females in his flock. The mother of this mosaic was a Barred Rock female and the father, if only one is involved, probably a Brahma. If the egg of the Barred Rock female were fertilized by a sperm from the Brahma the genetic constitution of the progeny should be heterozygous for barring, pea comb, feathered shank, and for extension of color (*Bb Pp Ff*

LEFT SIDE OF MOSAIC

Figure 6

Showing the light plumage and feathered shank typical of the Brahma. This side is definitely larger than the other and the leg apparently longer. The standard of the Brahma breed is about twenty-five per cent heavier than the Barred Rock, so that this difference in size of the two sides is definitely a breed characteristic.

Ee). Normally such a bird would show barring, pea comb, and feathered shanks. On the basis of the explanation that the difference between Brahmas and Barred Plymouth Rocks is due to the absence of an extension factor (*E*) in the Brahma, which causes pigment to be restricted to neck, wing, and tail feathers, the left side of this mosaic does not have *E*. Since feathering of shank is dominant, or partially so, to clean shank the right side of the bird does not have *F*. Crew suggests that all seven cases which he discussed can be explained on the basis of a loss of a part or all of an autosome. According to this explanation, the present case would be due to the loss of a part or whole of two autosomes, one carrying the gene for feathered shank and the other carrying the factor for extension of pigment. Also, the loss involving the gene for feathered shank would

occur on the right side and the loss of the gene for extension would have to occur on the left side.

On the basis of this explanation the larger size of the left side could be explained as being due to size genes of greater positive effects linked with feathered shank, than genes for size linked with extension. According to the Standard of Perfection, the Brahma breed is larger than the Plymouth Rock breed. The standard for Brahma cockerels is twenty-five per cent greater than that for Plymouth Rock cockerels.

Two other possible explanations, somatic gene mutations and non-disjunction of the chromosomes, have been offered as an explanation of this type of mosaic. In the cases previously reported aside from sex differences the two sides differ in only one character. The present case differs in two if size is not included. The occurrence of a mosaic with more than one character involved would be expected much less frequently than one with only one character involved. Especially this would be true in the case of somatic gene mutation. Unfortunately, because of the accidental destruction of this bird, opportunity for possible mating and examination of the gonads was lost.

Literature Cited

1. Crew, F. A. E., 1928. A case of lateral asymmetry in the fowl. *Jour. Genetics*, XX, 179-186.

2. ————————, 1932. A case of leg-colour asymmetry in the fowl. *Jour. Genetics*, 25, 359-365.

3. Knox, C. W., 1931. Color chimeras in the domestic fowl. *Jour. Heredity*, XXII, 133-134.

4. Lambert, W. V., 1929. A half-and-half skin color mosaic in the chicken. *Jour. Heredity*, XX, 167-169.

5. Macklin, M. T., 1923. A description of material from a gynandromorph fowl *Jour. Exp. Zool.* XXXVIII, 355-375.

Peony Twins

I WAS interested to read in the October issue of the Journal of Heredity Prof. Waller's account of the occurrence of twinning among seedling irises. I have had occasion during the past twenty years to handle with considerable care many thousands of young peony seedlings, and only once have I observed a case of twinning among them. This was in a group of seedlings of *Paeonia cambessedesii* set out from a flat in the summer of 1931. Unfortunately I did not photograph the plants. However, one could hardly be mistaken in the case of the peony for most species in this genus, including cambessedesii, do not bring the seed-leaves out of the seed and one can sometimes find the shell of the seed still attached to the young plant even in its second year of growth. In the case in question I washed all the earth off from this peculiar little specimen and saw very clearly that both of the little plants were connected to the single seed.

I regret to say that *P. cambessedesii* does not seem happy with me, and that both of these twin plants have since died. But I should like to put this case on record, since we may find that twinning is not so rare among plants as has been supposed; for no cases would be likely to come to light except where seedlings are handled with a good deal more care than they usually get.

A. P. Saunders
Hamilton College, Clinton, N. Y.

CLUBBING OF THE FINGERS INHERITED

First Instance Reported in Negro Race

J. THORNWELL WITHERSPOON
School of Medicine, Tulane University

CLUBBING of the fingers and toes has long been recognized as a clinical manifestation of intrathroracic disease but it is still a rarity in medical literature to find this condition mentioned as of primary origin. The present case is considered worthy of reporting, not only because the simple clubbing of the fingers and toes is congenital and possibly hereditary, as far as can be determined from the history, but it is also the first case of primary clubbing in the negro to be encountered in reviewing the literature.

The patient is a 44 year old colored man who has done hard labor all his life. He offers no chief complaint, and was discovered only in checking over him in a routine periodic health examination. The general physical examination employing the usual methods of examination indicated that the individual was entirely normal except for the marked clubbing of the fingers and toes. X-ray of the chest presented no pulmonary or cardiac disease. The Wassermann reaction was negative. The patient states he has had clubbed fingers and toes as long as he can remember, and that his mother tells him he had them when born.* His father (deceased) had similar clubbing, and the mother claims the father's condition was also congenital. The condition of the fingers and toes of the grandparents is unknown to the patient or to his mother. The patient has three brothers and one half brother (maternal) who present similar clubbing of the fingers and the toes; all claim to have had the condition as long as they can remember, and again the mother states the condition was congenital in all. The patient's mother and four sisters present no clubbing.

Other Instances

On reviewing the literature on the hereditary tendency of primary clubbing of the fingers and toes, nine cases were noted. Fraentzel,[3] in 1888, described a case of clubbed fingers in a man whose father and a healthy sister were likewise affected. In 1891, Freytag[4] observed two cases of primary clubbing of the fingers; each patient had a healthy father whose fingers were also clubbed. Newton and Mercellis[7] reported a case of simple clubbing of the fingers in a healthy white male, thirty-eight years old. The patient's paternal grandfather, brother, daughter and three dead children presented the same condition. The patient's father, mother, and sister had no clubbing. Von Eiselsberg[2] described congenital, familial, and hereditary clubbing of the terminal phalanges in a white man, thirty-five years old; one grandfather, one uncle, and one sister had a similar condition.

Parkes-Weber[5] has reported a case of primary clubbing in a healthy white male, twenty-five years old, who had had clubbed fingers and toes as long as he could remember. His father, three brothers, and one sister were similarly affected. Crouzon and Gutman[1] described primary clubbing of the fingers in a white man thirty years old. The patient had always had this condition, and his father was also affected. The patient did not know if his father's condition was congenital or acquired, nor did he know the condition of his father's fingers at the time of the patient's conception. Neurath[6] commented upon a case of hereditary clubbing of the

*The veracity of this statement must be weighed in the light of the negro's ability to observe pathological conditions.

CLUBBED FINGERS DUE TO HEREDITY NOT DISEASE
Figure 7

Diseases of the lungs and heart have long been known to produce a characteristic clubbing of the fingers but not all such fingers are due to this cause. Spatulate fingers have been reported as an inherited characteristic in several white families but this case appears to be the first one reported in the Negro Race.

thumbs. Recently Kayne[5] reported a case of hereditary clubbing of the fingers and toes in a white male, thirty-two years old. There were no physical signs of heart or lung disease, and the X-ray of the chest was normal. The patient had had this condition as long as he could remember. His father and one brother were similarly affected, while his mother, two brothers, and three sisters presented no evidence of clubbing. Lastly Ragins and Freilich[9] described a case of familial, congenital and hereditary clubbing of the fingers and toes in a white man, thirty-four years old. One sister, father, and paternal uncle presented the same condition.

Literature Cited

1. Crouzon and Gutman, 1931. Hereditary Hypertrophic Fingers. *Bull. Mem. Soc. d. Hosp. de Paris,* 47:1765.
2. Von Eiselsberg, 1911. *Munch. Med. Woch.,* 58:1591.
3. Fraentzel, 1888. Ueber Akromegalie. *Beutsche Med. Wchnschr. s.,* 651.
4. Freytag, 1891. *Ueber die Trommelschlagelfinger und Knochenverangerungen bei chronischen Lungen und Herzcrankheiten.* Bonn.
5. Kayne, G. G., 1933. Familial Clubbing of the Fingers and Toes. *Proc. Roy. Soc. Med.,* 26:270.
6. Neurath, R., 1932. Hereditary Clubbed Thumbs. *Wien. Klin. Wchnschr.,* 45:1210.
7. Newton, R. C., and E. Mercellis, 1902. A Case of Pulmonary Osteoarthropathy. *Int. Clinics,* 4:11th series.
8. Parkes-Weber, F., 1919. The Occurence of Clubbed Fingers in Healthy Persons as a Familial Peculiarity. *Brit. Med. J.,* 2:379.
9. Ragins, O. B., and E. B. Freilich, 1933. Familial Congenital Clubbing of Fingers and Toes. *Ann. Int. Med.,* 6:946.

SELECTIVE FERTILIZATION

P. W. WHITING*
Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, N. Y.

LIKE many other wordy battles, that concerning selective fertilization hinges largely on definition of terms. Lillie[19] says: "fertilization is essentially the phenomenon of the union of two cells known as gametes to form a single cell known as the zygote." Students of the fungi distinguish between union of the gametic cells (plasmogamy) and union of the gametic nuclei (karyogamy). In the higher plants fusion of the gametic nuclei in the embryo sac is called syngamy while the word fertilization is often used in a broader sense to include growth of the pollen tube as well. Differential pollen tube growth has been called gametophytic selection, selective pollen tube stimulation, gamolysis and certation. Jones[12] wrote in 1928: "terms of this kind are very apt to become confusing. For that reason the writer prefers to use the general term 'selective fertilization' to cover broadly all forms of discrimination in reproduction." This definition might be extended to include factors of geographic distribution, differences in size and structure, agents concerned in pollination or transfer of pollen from anther to stigma and, on the human side, race, political and religious prejudices as well as pecuniary acquisitiveness and parental influence. Obviously if fertilization is understood in so wide a sense we shall find no end of discrimination in reproduction. But according to Jones "if we limit the definition of fertilization to the fusion of two cells, the gametes, to form the zygote, there is no clear case known of a selective action within the species where the individuals are all compatible with each other" for, adds this author, "chance recombination of the germ cells which take part in sexual reproduction is one of the main tenets of mendelism" and the word "selective fertilization has been employed to account for exceptions to the usual mendelian mode of inheritance that needed no such interpretation." The facts are in many cases adequately explained by differences in viability of different genetic types.

Let us consider the various phenomena to which the term selective fertilization in a broad sense may be applied, recognizing that the limits of the definition must be somewhat arbitrary and let us also consider whether or not there is now convincing evidence for selective fertilization in the restricted sense of selective syngamy.

Sex of Gametes

Among the zoöspores of different species of algae there is to be found a wide range of differences in size and ability to develop independently or to unite together in pairs when they function as gametes and produce the zygospores. Varying degrees of difference in size (anisogamy) occur, the smaller elements tending to select the larger and, in the more specialized types, active sperm (microgametes) become readily distinguishable from passive eggs (macrogametes). Among the molds, Mucor and related genera, sexual reaction to form zygospores takes place between plus and minus strains, but different degrees of plus and minus occur so that a certain clone which acts as plus in one test may act as minus in another. Thus there is selective fertilization with respect to sex of the gametes. In the higher forms eggs become so markedly distinct from sperm that one

* The author wishes to acknowledge support during the preparation of this paper by a grant from the Penrose Fund of the American Philosophical Society.

takes union of male with female gametes for granted. Even here, however, the intrinsic possibility remains that development may result from union of a male nucleus with a male or of a female with a female, as is illustrated by fusion of polar nuclei in insect eggs and in the endosperm of plants, by fertilization of egg with polar body, by fusion of cleavage nuclei and by fusion of sperm nuclei in egg fragments. These unions may be followed by more or less cleavage and development which differ greatly in different cases (parthenogamy, diploid merogony).

Preferential Assortment of Genes and Chromosomes

In the formation of spores and of gametes, either male or female, random assortment of genes, although assumed to be the rule in discussion of simple mendelism, is usually not the case. Linkage phenomena interfere and in chromosome distribution also there is much evidence of preferential assortment regardless of whether the favored combinations have been introduced together or not. Thus in triploid Drosophila there is wide deviation from random assortment so that two *X*-chromosomes tend to segregate more frequently with one second and one third chromosome than with two second and two third chromosomes. Non-disjunctional females, *XXY*, likewise produce a greater excess of *X* and *XY* eggs over *XX* and *Y* eggs than would be expected on a random basis (if homeosynapsis and heterosynapsis were equal). Sturtevant[26] has recently reported that a certain duplicating chromosome element shows different degrees of repulsion from different fourth chromosome factors regardless of whether it is brought into the cross in combination with those factors or with their allelomorphs. This preferential segregation is much more marked in maturation of the egg than of the sperm. Limitations to random assortment of genes in maturation illustrate discrimination in reproduction in a broad sense, not selection as regards combinations already formed.

Gametic and Gametophytic Lethals

Among certain groups showing parthenogenesis, such as phylloxerans and aphids, the second spermatocyte lacking the *X*-chromosome degenerates without dividing into spermatids, although in the grasshoppers and other forms reproducing bisexually this does not occur. It is questionable whether there are gametic lethal genes, but obviously certain chromosome combinations may render the gamete inviable.

Gametophytic lethals segregate in pollen formation so that there is selective action hindering progress of one type of sperm nucleus toward the egg. The literature on self- and cross-incompatibility in plants contains many interesting examples of differential pollen tube growth resulting in wide disparity from mendelian expectations for factors linked with the lethal.

Sperm and Egg Cell Combinations

Selective action among types of sperm in their progress toward the egg occurs in marine forms where a mixture of sperm from different species is present in the water. There are undoubtedly chemotactic properties associated with ova which ensure that they shall each be fertilized by spermatozoa of the same species only. It has been suggested that a high male ratio may be due to greater rate of motion of the sperm lacking the *X*-chromosome. The problem is so complicated by sex differences in viability at different ages and by the occurrence of sex-linked lethal factors that the initial sex ratio is very problematical.

There appears to be no evidence for selection in favor of the dominant or the recessive among the sperm pro-

duced by a male heterozygous for any given gene. All evidence points to initial equality of zygotes formed. Sperm mixtures from different males however appear to indicate selection in favor of one type. Experiments have been carried out with birds and mammals to test the possibility of such selective action in the case of double mating. Thus Crew[3] mated White Leghorn hens both with White Leghorn cocks and with Redcap cocks obtaining 72 White Leghorns and only 17 Redcaps. Dunn[7] crossed Leghorn hens with Rose Comb Hamburg cocks and with Leghorn cocks and found that ninety per cent of the offspring were sired by the closely related male. He obtained similar results with White Wyandottes mated alternately with White Wyandottes and with Silver Spangled Hamburgs or Pea Comb Pit Games (92 were sired by related and only 15 by unrelated). On the other hand King's[16] results from double matings of white female rats with black and with white males showed an excess of the black offspring. These results are all open to the objection that the mixture of sperm may not have been thorough enough and that the relative quantity of each type is unknown.

Various attempts have been made to modify the sex ratio by subjecting eggs to different conditions. Thus by allowing frog eggs to become overripe before they were fertilized, Hertwig[10, 11] obtained seventy to ninety per cent males while Kuschakewitsch[18] obtained males only. As mortality was only four to six per cent in the latter experiment, it is not possible to explain the results as due to differential viability. King[14] subjected toad eggs to dryness and obtained an excess of females.

She concludes that these results "would seem to indicate that the relative amount of water in the egg at the time of fertilization has some influence in determining sex; an increase in water content tending to produce a male, a lowering of the water content favoring the development of a female." Two kinds of spermatozoa may have been present, male determining and female determining. "The solutions rendered the eggs more resistant to the entrance of one kind of spermatozoa than to the other." In a later paper[15] she says that the experiments "strongly suggest that in Bufo sex does not depend exclusively on the spermatozoon, but that it is determined by the egg alone, or by both egg and sperm."

Sex-reversal has been suggested to explain these cases in the Amphibia. There is also the possibility that maturation may not be random. Some condition within the egg may cause one type of egg nucleus rather than the other to be extruded in the polar body.

Zoologists frequently think of fertilization in the sense of penetration of the egg by the spermatozoon. Fertilization membranes are formed and there are many other changes which prevent all but certain types of sperm from entering and also act against polyspermy or penetration by more than a single sperm.

Castle[2] determined that in the hermaphroditic ascidian, Ciona, the gametes ripen at the same time, but the eggs of one individual are rarely fertilized by the sperm of the same individual. Morgan [20, 21] showed that self fertilization in Ciona occurred if the membrane was removed. The block to self-fertilization is due to the test cells between the egg and the membrane. Morgan wrote, "the relation involves a reaction between maternally derived substances (that have the same genetic inheritance as the cells from which the spermatozoa are derived) and their 'own' spermatoza."

This may be compared to the phenomenon of self-sterility in tobacco and certain other plants. East and Mangelsdorf[8] reported that in tobacco the pollen tube is unable to grow in the style of a plant having the same member of a multiple allelomorphic series concerned with sterility. Accordingly all plants would be self sterile and none homozygous, but it was later found that

there are certain members of this allelomorphic series that counteract self sterility so that homozygous plants may be obtained.

Selective Syngamy

Selective fertilization in the restricted sense of selective syngamy (union of gametic nuclei) is illustrated by certain cases of gynogenesis or development from the female nucleus alone which has been stimulated by the presence of the sperm nucleus. In a cross between a sea-urchin and a mollusk (Echinus ♀ × Mytilus ♂) Kupelweiser[17] observed the degeneration of the sperm nucleus in the egg cytoplasm. This shows discrimination against the Mytilus sperm even after it had entered the egg. A comparable case has been shown for plants by Jorgensen[13] (*Solanum nigrum* ♀ × *S. luteum* ♂) with the male nucleus degenerating after entering the egg. Plough[23] has recently shown selective syngamy in the hermaphroditic ascidian *Styela* (*Cynthia*) *partita*. "The selfed eggs have many sperm inside the membranes and test cells and in close contact with the egg cortex. Fertilization has not taken place, as is shown by the presence of the intact first maturation metaphase. In the crosses, however, the sperm do penetrate, and the eggs go into cleavage." This selective syngamy appears to be the first exception to Jones statement that "there is no clear case known of a selective action within the species where the individuals are all compatible with each other."

Chromosome Elimination

A selective action against the paternal chromosome contribution may take place even after syngamy has occurred. Such elimination means that fertilization in a genetic sense has failed although the syngamy has stimulated cleavage of the maternal elements (gynogenesis). In Echinoids, Baltzer[1] has shown elimination of paternal chromosomes in early cleavage. The tendency to elimination varies inversely to degree of taxonomic relationship of the male to the female.

Differential Maturation

Of the four nuclei resulting from meiosis in the animal egg or in the plant megaspore mother cell, only one functions to perpetuate the next generation. As regards plants there is no clear evidence as yet that this nucleus is selected on any genetic basis. The choice appears to be random.

Among different species of animals the polar nuclei may be budded off from the egg cell as typical polar bodies or merely isolated more or less peripherally within the egg cytoplasm. In the latter case definite polar nuclei may be formed or the chromosome sets resulting from the second meiotic division may remain as such, failing to form a nuclear membrane. Does differential maturation occur in the sense that under certain conditions choice of the definitive egg nucleus is not random, but that one genetic complex is more likely to be fertilized than its alternative?

Progamic Sex-Determination

The sex of an organism has often been thought to be determined by differences in the chemical composition of the egg, the water content, or the storage metabolism. Such differences are present before syngamy and are hence called progamic. In the case of species with digametic females progamic and environmental factors may perhaps influence polar body formation in such a way that the *X*-chromosome is not distributed at random. This has been suggested to explain disparity in sex ratios of frogs and toads, as well as such cases in birds as are not due to differential mortality or to sex-reversal. There is much difference of opinion as regards significance of data and their interpretation (Riddle,[24] Goldschmidt[9]).

Sex-determination in the worm Dinophilus is of this progamic type. Two kinds of eggs are produced, large and small, the former giving rise to females

the latter to males. This sex-differentiation of the eggs occurs before fertilization. There is no parthenogenesis and both types of eggs must be fertilized. According to Nachtsheim[22] all sperm are alike containing ten chromosomes and the maturation divisions of the eggs are also regular, resulting in all cases in ten chromosomes. It has been suggested that the females are digametic and that differential maturation occurs, the *X*-chromosome remaining in the large eggs, the *Y*-chromosome in the small eggs.

Differential Maturation in Moths

Doncaster[4, 5, 6] reports a strain of the currant moth, *Abraxas grossulariata,* in which there were 55 chromosomes in the female instead of the usual 56. Many fraternities consisted entirely of females and when these females were crossed to males with the sex-linked recessive factor lacticolor, all daughters were lacticolor. The dominant allelomorph had apparently been eliminated with the *X*-chromosome. Egg counts showed that the all female families were not caused by non-viability of the male zygotes. It was at first thought that the *X*-chromosome was eliminated at the first oöcyte division, but later it was concluded that this was random, taking place in only half of the cases. Since the second division had an equal number of chromosomes going to each pole, it was supposed that the elimination must be at a later stage, as in the first cleavage division.

Seiler[25] has shown in a Psychid moth that the males have sixty chromosomes in the spermatogonia and the females have fifty-nine in the oögonia. The odd chromosome passes undivided to one pole in the first oöcyte division. The second division is equal and the sperm brings in thirty chromosomes so that the zygote formed should have either sixty or fifty-nine chromosomes according to whether the odd chromosome remained in the egg or passed out into the first polar nucleus. Embryos are of two types, those with sixty chromosomes (presumably males) and those with fifty-nine (presumably females). There is wide diversity of sex ratios in animals collected at different places and in bred material. Environmental influences apparently have an effect. Study of eggs which had begun maturation under different conditions showed differential maturation. The *X*-chromosome went into the polar nucleus in 38.2 per cent of cases in a high temperature experiment, in 57.5 per cent at room temperature and in 60.5 per cent in a cold experiment. If females were kept for a few days after eclosion before being mated this percentage was 41.1. Overripening of the eggs like high temperature caused an excess of males.

Sex-Determination in Bees and Wasps

In bees and wasps, males normally develop from unfertilized eggs and are haploid, while females come from fertilized eggs and are diploid. By means of a sex-linked factor it has recently been shown[27] that, in the parasitic wasp Habrobracon, females are digametic, *X*/*Y*, for the sex chromosomes and produce from unfertilized eggs two kinds of males, *X* and *Y*, in equal numbers. All sperm produced by any one male are alike, either *X* or *Y*. Both *X* and *Y* chromosomes are present in the unreduced egg at the time the sperm enters. If a female, *X*/*Y*, be crossed with an unrelated male, *X* for example, the fertilized eggs develop into females. These facts indicate that there is differential maturation so that the nucleus with the *X*-chromosome becomes the polar nucleus and the *X* sperm unites with the remaining *Y* egg nucleus to form a female. We have here genetic evidence for a second case of selective syngamy "within the species where

the individuals are all compatible with each other."

The nature of sex-determination in bees and wasps as revealed by studies on Habrobracon will be discussed more fully in a later paper.

Literature Cited

1. Baltzer, F., 1910. Uber die Beziehung zwischen dem Chromatin und der Entwicklung und Vererbungsrichtung bei Echinodermenbastarden. *Arch. f. Zellforsch.*, 5:497-621.
2. Castle, W. E., 1896. The early embryology of *Ciona intestinalis*. *Bull. Mus. Comp. Zool.*, Harvard College, No. 27.
3. Crew, F. A. E., 1926. On fertility in the domestic fowl. *Proc. Roy. Soc. Edinburgh*, 46:230-238.
4. Doncaster, L., 1913. On an inherited tendency to produce purely female families in *Abraxas grossulariata* and its relation to an abnormal chromosome number. *Jour. Genetics*, 3:1-10.
5. ———— 1914. On the relations between chromosomes, sex-limited transmission and sex-determination in *Abraxas grossulariata*. *Jour. Genetics*, 5:1-22.
6. ———— 1922. Further observations on chromosomes and sex-determination in *Abraxas grossulariata*. *Quart. Jour. Mic. Sci.*, 66:398-408.
7. Dunn, L. C., 1927. Selective fertilization in fowls. *Poultry Science*, 6.
8. East, E. M., and Mangelsdorf, A. J., 1926. Studies on self-sterility. VII. Heredity and selective pollen tube growth. *Genetics*, 11:466-481.
9. Goldschmidt, Richard, 1931. Die Sexuellen Zwischenstufen. *Monographien aus dem Gesamtgebiet der Physiologie der Pflanzen und der Tiere*. 23:328-336.
10. Hertwig, R., 1906. *Weitere Untersuchungen über das Sexualitätsproblem*. Verhandl. deutsch. zool. Gesellsch.
11. ———— 1907. *Untersuchungen über das Sexualitätsproblem*. III. Verhandl. deutsch. zool. Gesellsch.
12. Jones, D. F., 1928. *Selective Fertilization*. Univ. of Chicago Press.
13. Jorgensen, C. A., 1928. The experimental formation of heteroploid plants in the genus *Solanum*. *Jour. Genetics*, 19:133-211.
14. King, Helen Dean, 1911. Studies on sex-determination in Amphibians. *Biol. Bull.*, 20:205-235.
15. King, Helen Dean, 1912. Studies on sex-determination in Amphibians. *Jour. Exp. Zool.*, 12:319-336.
16. ———— 1929. Selective fertilization in the rat. *Roux's Arch. Entw.*, 116: 202-219.
17. Kupelweiser, Hans, 1912. Weitere Untersuchungen über Entwicklungserregung durch stammfremde Spermien, inbesondere über die Befruchtung der Seeigeleier durch Wurmsperma. *Arch. Zell.*, 8:352-395.
18. Kuschakewitsch, S., 1910. Die Entwicklungsgeschichte der Keimrüsen von *Rana esculenta*. *Festschr. f. R. Hertwig*, Jena.
19. Lillie, F. R., 1919. *Problems of Fertilization*. Univ. of Chicago Press.
20. Morgan, T. H., 1910. Cross- and self-fertilization in *Ciona intestinalis*. *Roux's Arch. Entw.*, 30.2:206-235.
21. ———— 1923. Removal of the block to self-fertilization in the ascidian *Ciona*. *Proc. Nat. Acad. Sci.*, 9:170-171.
22. Nachtscheim, H., 1919. Die Bestimmung des Geschlechts bei *Dinophilus*. *Sitz.-Ber. Ges. Morph. Physiol.* München, pp. 1-8.
23. Plough, H. H., 1933. Selective fertilization in *Styela*. *Biol. Bull.*, 65:365.
24. Riddle, Oscar, 1927. Proofs and implications of complete sex-transformation in animals. *Verhandl. des I. International Kongresses f. Sexualforschung*, 1:193-218.
25. Seiler, J., 1920. Geschlechtschromosomenuntersuchungen an Psychiden I. Experimentelle Beeinflussung der geschlechtsbestimmenden Reifeteilung bei *Talaeporia tubulosa* Retz. *Arch. f. Zell. f.*, 15:249-268.
26. Sturtevant, A. H., 1934. Preferential segregation of the fourth chromosome in *Drosophila melanogaster*. *Proc. Nat. Acad. Sci.*, 20:515-518.
27. Whiting, P. W., 1933. Selective fertilization and sex-determination in *Hymenoptera*. *Science*, 78:537-538.

✦

JUST WHAT IS A EUROPEAN?

Racially and geographically rather complicated note from the *Journal* of the American Medical Association (Vol. 103, page 425):

"In 1920, 91.7 per cent of the Europeans in the Dutch East Indies were Netherlanders, 4.7 per cent were Americans and Australians, 2.5 per cent were Japanese, 0.3 per cent were Chinese, and 0.8 per cent belonged to groups of Europeans of the second generation."

THREE GENERATIONS OF ALBINISM AND TWINNING

ERNEST WINDLE
Avalon, California

WHITE HAIR AND BLACK

Figure 8

Albino and normally pigmented twin boys of Mr. and Mrs. Daniel Rios, Santa Catalina Island, California. Three other children are normally pigmented. There is a tradition that the twins' great, great grandmother was an albino, and other cases of albinism are reported in the family. Where both parents carry a gene for albinism, there is one chance in four that a given child will be an albino. The same laws of chance apply in the case of non-identical twins and this case is of interest rather because of the extreme variation in the characteristics of the twins than because there is any inherent probability that such an event would occur if albino genes were present in both parents.

LIONEL and Daniel Rios, who were born at Avalon, Santa Catalina Island, some 3½ years ago and are the twin sons of Mr. and Mrs. Daniel Rios, are in excellent health, according to a statement recently made by Dr. D. G. Bussey, of the Catalina Hospital, who was the attending physician at their birth.

Lionel is an albino with white hair and eyes that have a pinkish cast, while Daniel has straight black hair, big black eyes, and is a typical offspring of Mexican parents. Mr. and Mrs. Rios have three other children.

It is said that the twins' grandmother's great-grandmother was an albino and that she married a non-albino and be-

came the mother of ten children, five boys and five girls. Her married name was Mrs. Saucedo. One of the girls of this family is said to have had one-half of her hair white and one-half black, one blue eye and one black eye; which, if the story could be verified, represents one of the few cases on record of a human mosaic. One of the boys of the same parents had one-half of his hair white and one-half black, both eyes black. All of the children are said to have been normal in their behavior.

The Rios twins grandmother's aunt was not an albino but had four albino boys, among them one set of twins, both albinos. Another aunt, not an albino, had three albino children.

The Rios twins, however, are the first set in the family in which one is an albino and the other normal, and the first albino to appear in the third generation.

As far as can be ascertained, all of the albinos, with the exception of one twin that died, have lived to maturity.

Lionel Rios, since his birth, has been the center of attraction in the Mexican colony in which the parents live at Avalon.

A year ago, Professor August Piccard and his brother Gene Piccard made a special visit to Santa Catalina Island to see the twins. The Piccard brothers are identical twins, and Gene Piccard was particularly interested in the mental reaction and the behavior of Lionel as a child.

Man in Prehistory

ALMOST fascinating account of man's origins, so far as they are now known, is given in *Adam's Ancestors.** The author has combined interest with authenticity, an ideal all too seldom attained by writers attempting to popularize scientific information. One gets a picture of both the method and the facts of prehistory. The author presents new materials and new interpretations of older findings in the light of what is now known. From the very nature of the case all of his colleagues will not agree with his conclusions, and this the author himself recognizes.

To the reader interested in heredity and evolution, the following excerpts from the book can best express what the author has to say on this aspect of his subject.

Perhaps some readers of this book, when they realize that prehistory has now traced back man of our own type to the beginning of the Pleistocene and has shown that he was contemporary with various other more primitive types of man and not evolved from them, will begin to think that here is evidence which is contrary to the theory of evolution. It has been suggested to me that since the results of our work show that *Homo sapiens* has changed so little in the long period of time known as the Pleistocene, this may be taken to indicate that this type of man has his origin in a special creative act, and is not the result of any normal evolutionary process.

This is certainly not the interpretation which I would put upon the available evidence. I should say rather that we have learnt that evolution has been very much slower than we have sometimes been led to believe. The presence of four completely different types of man at the beginning of the Pleistocene suggests to me that their common ancestor must be looked for in deposits at least as old as the Miocene period. The further fact that in deposits of Miocene Age we have evidence of the existence of anthropoid apes very akin to those still living today must suggest that the common ancestor of man and the anthropoids will have to be sought in deposits of still greater age. There can be little doubt now that man has been in existence upon the earth much longer than the million years assigned to the Pleistocene period.

M. A. McCall

U. S. Department of Agriculture

*Leakey, L. S. B., *Adam's Ancestors.* Price, $3.20. Longmans, Green & Company, New York, 1934.

HOW SHALL WE KNOW PLANTS?

GENETICISTS take for granted a world of knowledge that other sciences have accumulated. Systematic botany is a growth of 2,000 years, from the time of Theophrastus. The naming of the natural groups, the species, genera, families, orders and classes, the formulation of the characters that distinguish the groups, and the descriptions of endlessly varied detail of forms and structures, properties and uses, are matters of knowledge that workers in genetics expect to obtain from taxonomists, morphologists, physiologists, and biochemists. But it is not safe for geneticists to enter the surrounding fields as random borrowers, since works of reference seldom can be trusted to supply the discriminating insight that the original investigator should command.

The study of heredity and evolution gives a new significance to the plant characters, which no longer appear as merely arbitrary differences between species, but trace back to a remote past, or may be projected to further development in the future. An interest in these characters is by no means confined to those who would breed new kinds of plants. An equal interest may be felt in knowing the plants as they now are, without any desire to make them different. For the intensive investigation of problems of evolution, heredity and breeding, it is important to choose the best material from the entire ranges of forms and characters presented in the different groups.

The practical needs of plant knowledge become greater with every discovery of new properties and uses, though only a small beginning has been made of the plant survey that is needed, most of our present knowledge being an inheritance from the remote past. Not only were all of the principal food plants discovered, domesticated and developed by prehistoric peoples, but also our knowledge of special properties in other plants is drawn very largely from primitive sources. The uses of rubber, quinine, cocaine, ipecac, jalap, sarsaparilla, tobacco and cacao were learned from the Indians of tropical America, and a vast body of of such aboriginal plant lore still remains to be collected and evaluated. Even with a substance so admittedly important as rubber, we have scarcely begun to take stock of the plant world. Having learned through fortunate accidents that one of the rubber-bearing species can be cultivated, we remain indifferent to other production possibilities that may exist among the hundreds of other plants that contain rubber.*

Difficulties of Plant Taxonomy

Perhaps by reason of laboratory training, many geneticists are closer to physiology and biochemistry than to taxonomy and morphology. They may have no clear conception of what classification means, and yet are very impatient when they find that two taxonomists use different names for the same plant, or that names are changed in different works of the same author. Why classifications and names must be changed with the advance of knowledge, is not understood, or that only gradual progress can be made toward the ideal of a stable nomenclature.

Botanical terminology is highly specialized, but often proves too indefinite for ready understanding by the unpracticed student. Even with the labor-saving device of "analytical keys," many of the doors to botanical knowledge are hard to open, and

*FAIRCHILD, DAVID. Dr. Ridley of Singapore and the Beginnings of the Rubber Industry. *Journal of Heredity* 19: 193-203. May, 1928. COOK, O. F. Beginnings of Rubber Culture. *Journal of Heredity* 19:204-215. RIDLEY, J. N. Early Days of Rubber Experiments. *Journal of Heredity* 19:485-486. November, 1928.

many entrants become discouraged when they reflect on the time spent in analyzing and interpreting poorly prepared descriptions, and the resulting slow progress toward an outdoor familiarity with the plant world. Long descriptions may be studied through without finding any statement of diagnostic differences between the species, even between genera. Descriptions drawn from pressed specimens may be difficult to translate into terms of living plants, as seen by naturalists or breeders. The characters used by taxonomists need in many cases to be reformulated, to bring them in line with genetic and developmental facts. The discovery and statement of new characters often contributes more to the progress of taxonomy than the discovery of new species.

The Number of Species

The problem of making the plant world accessible is much more difficult than was formerly supposed, because the species of higher plants are much more numerous than seemed possible at first. The floras of some of the tropical countries are extremely rich, especially in trees and climbing vines, and many of the species are of astonishingly limited distribution. Richard Spruce estimated in 1858 that 50,000 to 80,000 species of flowering plants remained to be described in the Amazon Valley, on the basis of his observation in the forests of Brazil, that "by moving away a degree of latitude or longitude I found about half of the plants different." The forest itself is the great impediment to the distribution of the species that compose it, though even in open countries the plant species may be greatly localized. No principle of paucity is apparent in the plant creation. Each of the floral provinces could prompt reflections like those of a pioneer missionary in South Africa, more than a century ago: "The immense variety of flowers and flowering plants and trees in Africa is truly wonderful. They proclaim the handy works of the Lord; and he must have some particular reason for affording such a display of his wisdom and power to the inhabitants of Africa."

Alpha and Omega of the Plant World

The problems of general plant knowledge may be illustrated by comparing two recently published books, one dealing with the highest group of plants and the other with the lowest group. The flowering plants are represented by Small's "Manual of the Southeastern Flora,"* and the slime molds by Macbride and Martin's "The Myxomycetes."† Small's Manual is a relatively local flora, while the work on slime-molds is a monographic treatment, covering the entire world.

It certainly would not be expected that the study and classification of the lowest group of plants should have been carried beyond the higher groups, but the jewel-like beauty of the slime moulds is very attractive, and their motile plasmodia have made them interesting as a border-line group, between animals and plants. The relatively small numbers of species among the slime-molds and the wide distribution of the species, have also facilitated study, so that knowledge of this entire group advanced rapidly, as shown in the succession of monographic treatments by Rostafinski, Cooke, Massee, Lister and Macbride, not to mention the

*Small, John Kunkel, Manual of the Southeastern Flora, being descriptions of the seed plants growing naturally in Florida, Alabama, Mississippi, Eastern Louisiana, Tennessee, North Carolina, South Carolina and Georgia. Published by the author, Printed by the Science Press, New York, 1933.

†Macbride, Thomas H., and Martin, G. W., The Myxomycetes, a descriptive list of the known species with special reference to those occurring in North America. The Macmillan Company, New York, 1934.

many writers who have included this group with the fungi.

Slime Molds in Genetics

From the standpoint of genetics and evolution a special interest may be claimed for the slime-moulds, because of the complete contrast which their structural characters afford with those of the flowering plants. It is customary to suppose that the cellular constitution of the plant-body is the necessary basis of structure and form, but the slime molds show structures that are not built of cells. As Macbride and Martin say, "The sporangium wall is not cellular in structure, but is in the nature of an excretion." The walls of the sporangia and the supporting strands or network of *capillitum* threads among the spores are formed of the residual material that the motile protoplasmic cells leave behind in passing to the spore stage. What may be described as a communal skin-shedding or slime-shedding takes place, amorphus in some of the slime-mold groups, but in others showing very distinct and characteristic patterns, almost as definite as in structures that are built of cells.

Although the sporangia are only ephemeral slime-bubbles, yet they are blown in regular and beautiful forms, and glisten with rainbow colors. Since all of the specialized sporangial structures have the same simple function of raising the mass of spores above the substratum, for drying out and blowing away, it is difficult to imagine that any selective factors have been involved in determining the different forms of sporangia that chiefly characterize the various genera of slime-molds. Many parallel developments may be seen in forms of slime-mold sporangia and of stamens in flowering plants, and also the patterns of the surface markings of slime-mold spores and of pollen grains could be arranged in parallel series, as smooth, papillose, reticulate, pitted, and variously banded.

That so many of the slime molds are known to have cosmopolitan distributions, is an evidence of the efficiency of the small spores as a means of wide dissemination, while the development of large seeds tends to limit species to small areas. Hence the great numbers of local species that have developed among the seed plants, while many of the species of slime-molds and other spore-plants are found to be the same in all parts of the world.

The slime molds show us a very primitive stage of cellular organization, merely a swarm of cells which associate and cooperate with each other, not for the purpose of structure-building as in the higher groups, but in order to move more freely in their naked protoplasmic state, by making direct use of the power of streaming motion that is reckoned as an inherent quality of the living cell material. This form of association involves no individual differentiation among the cells as in the groups where cellular structures are built. In the stage of being enclosed in firm membranes the slime-mold cells are not associated for structural growth. The sporangia are only the communal scaffolds for drying and scattering the spores. How the group controls are exercised in the cell-swarm colonies of the organism, or in dividing the colonies and forming the sporangia, is a question not without bearing upon general concepts of heredity. Even in the higher groups there is an early stage where the cells are undifferentiated and appear to be more or less interchangeable without the developmental pattern being affected.

Taxonomic Treatments Compared

All of the larger genera and the more common species of the slime molds have been known for a century or more and have received careful study by numerous specialists, so that the taxonomic botany of the

slime-mold group is much nearer to being complete than the study of the flowering plants, where the species are vastly more numerous and the structures to be described and distinguished are vastly more complex. The work of Macbride and Martin recognizes 377 species of slime-molds from the entire world, while in the single segment of the flowering plants treated in Small's Manual, 5557 species are recognized, or nearly 15 times as many species of flowering plants in the southeastern States as in the entire world-flora of the slime molds. To estimate a thousand times as many species of seed plants as of slime molds would not be unreasonable.

The slime molds are classified in 4 orders, 14 families, and 59 genera, as compared with 58 orders of flowering plants, 233 families, and 1518 genera represented in the southeastern section of the United States. To treat the Southeastern Flora on the scale of the slime-mold monograph, about 15 volumes would have been needed, but Small has condensed his material to 1554 pages, roughly corresponding by pages to three volumes of the Macbride and Martin monograph. More than the 15 volumes would be required for the Southeastern Flora if all of the species were illustrated, instead of only one species in each genus. But so many genera are monotypic that only about four times as many drawings would be needed to illustrate all of the species of the Southeastern Flora.

Road Maps for the Plant World

In the nature and handling of the illustration material, Small's Manual may be considered as a notable advance toward making the plant-world of a large region more accessible to students and nature-lovers. Thousands of beautiful illustrations of plants have been published, but are accessible to few students and not available in the field, so that the beginner is thrown back on descriptive works. Many manuals and text books have been illustrated with many drawings, but often in the form of sketches of the general appearance of the plants or of flowers or inflorescences, and usually with no consistency of treatment to allow the essential characters to be compared.

Glossaries of botanical terms have been illustrated and series of small diagrams have been used in analytical keys or in local floras of some of the European countries, but graphic aids to the study of large floras usually have been furnished only to a limited extent. To provide such assistance in a regular and consistent manner, so that the essential characters of each genus can be seen as well as read, may be taking an important step. It is a great advantage to the student to have each genus illustrated, including the common weeds as well as the rare and local forms that the student may never see, or may have no opportunity to dissect.

Showing the characters of a single species to illustrate the genus also is a better plan than some writers have followed in illustrating generic descriptions by characters drawn from different species. Such illustrations are confusing to the student, since none of the species may correspond to the composite generic illustrations. Greater condensation is made possible by the use of simple drawings that speak for themselves and need nothing in the way of cross-references or explanations. Not only space is saved, and time in referring to plates or figures, but also many risks of typographic errors are avoided. The principal advantage is that the student works with visual forms, instead of relying upon the relatively abstract and indefinite ideas that come from the reading of descriptions. That so many of the groups of the higher plants are recognized only by floral characters, is another indication of the really backward state of de-

scriptive botany. Most of the drawings in Small's Manual are credited to Miss Mary E. Eaton, and appear to be very well done. The illustration for each genus usually is composed of six or seven detail drawings of flower or seed characters, so that the total number of drawings approaches 10,000. Showing the plant structures in simple drawings requires a special talent like that of the cartoonist, and is a worthy field for the exercise of graphic ability. A frequent tendency is to form a composite impression and then to make a series of drawings that look much more alike than the originals. Group monographs are much needed, and could be made in really portable form, with all of the species shown by their critical features.

Enrichment of the Flora

Introduced plants must be included in a manual for general use. The student who has struggled in vain to identify a very common plant, is not consoled by learning that it is a foreign species, not in the book. Most of the economic plants of the tropics can be grown in southern Florida, and are being introduced and assimilated gradually. Hundreds or thousands may be added eventually. Several Asiatic trees, as Melia, Ailanthus, Papyrius (*Broussonetia*), Albizzia, Lagerstroemia and Camphora, are prominent features in southern cities, with only the live-oak and pecans to assert the dominance of the native flora. The massive camphor trees of New Orleans, Mobile and northern Florida are evidence that Small's description of Camphora as a "small tree or shrub" (p. 921) is inadequate.

The avocado, the sapodilla, the guava, the tamarind, and the papaya are recognized by Small, but not Carissa, Eriobotrya, Melicocca, Mammea, Strychnos, Aleurites, Ceiba, Cecropia, Schinus, Eucalyptus, Bambusa, Chayota, or Xanthosoma. Melicocca is a common tree at Key West, though not noted on the mainland. Mammea is sparingly represented in Miami, and is a slow-growing tree, but of striking appearance, somewhat like a Magnolia. The cassava plant has its Linnaean name, as *Jatropha manihot,* but the physic-nut, *Jatropha curcas,* does not appear, nor either of the species of Aleurites, the tung-oil tree (*A. fordii*) and the candle-nut (*A. moluccana.*) The Chinese tallow-tree now widely planted and usually known as *Sapium sebiferum,* is called *Triadica sebifera* (L.) Small. The edible fig and *Ficus elastica* are included, but not other species which are equally common, or more so, as *altissima, nitens, bengalensis, religiosa,* and *scandens.* Several other tropical rubber trees, including *Hevea brasiliensis, Manihot glaziovii, Castilla panamensis,* and *Funtumia elastica,* are growing and fruiting in southern Florida, and likely to become established. A small Hevea tree in an unfavorable place at Palm Beach is more than 30 years old.

Three species of Gossypium are recognized, *barbadense, hirsutum* and *herbaceum,* but neither of these names is applicable to the native cottons of Florida, which are now being exterminated in the effort to suppress the pink bollworm. A cotton that was common in door-yards at Key West probably had been introduced from Honduras or the West Indies, but four distinct types of wild native cottons were recognized in a study that was made several years ago. Several peculiar characters were observed, which have not been recognized in other wild cottons or in any of the domesticated species. As a part of the tropical flora of Southern Florida, the existence of these native types of cotton is a matter of botanical interest.

The large plants at Key West had the leaves mostly 5-lobed, the flowers deep yellow and rather large bolls resembling those of Sea Island cotton but the lint pure white, not very fine and relatively short, not exceeding 1¼ inches, the lint restricted to the upper part of the seed and the lower part covered with a dense brown fuzz. The external nectaries commonly were covered with white

incrustation that suggested the specific name *Gossypium leucadenum*.

The wild cotton around Miami had white lint and nearly naked seeds, the leaves with short, flat, straight-sided midlobes, the involucral bracts with short narrow auricles, the flowers, including the anthers and the pollen, creamy white, suggesting the name *Gossypium synochrum*, and the bolls smooth-surfaced with scattered oil glands, absent along the sutures. The other wild cottons have brownish lint, densely fuzzy seeds, deeply auriculate bracts, golden-yellow pollen, and bolls with deeply pitted oil-glands over the whole surface.

The wild cotton of Tavernier and Matecumbe Keys had very small woody bolls less than 2 cm. long, rigid when mature and not widely opened, the lint rusty brown, less than half an inch long, very silky and smooth, so that the seeds showed no tendency to cohere or to remain attached to the plant, so that the name *Gossypium lysinum* was suggested. The other wild cottons, one on Terra Ceia island near Bradenton, and another at Key West were alike in having larger bolls of thinner texture and more widely opened, and pale buff lint more than an inch long, readily twisted into threads and holding many of the seeds suspended.

The Terra Ceia cotton (*Gossypium terraceium*) had a dense persistent pubescence on the stems and leaves, the involucral bracts with short broad teeth, the lateral margins and auricles usually entire, the bractlets very slender and pilose, the bolls closely beset with numerous small oil-glands, the funiculus covered with brown fuzz like the seed, and the lint fibers very fine and strong.

The wild cotton around Key West was nearly naked, with the teeth of the involucral bracts slender and flexuous, extending along the margins and often to the base of the auricles, the bractlets forming small tooth-like prominences along the margins of the inner nectaries, suggesting the name *Gossypium ceratadenum*, the bolls deeply and rather remotely pitted with very large oil-glands, the funiculus naked, and the lint fibers delicate and rather weak.

The generic description of Cryptostegia (p. 1065), relating to the Madagascar rubber vines, refers to "5 entire or 2-lobed scales attached to the corolla," which may be an impression from pressed specimens, the appendages at the base of the corolla not being flat but subulate. The species that Small has figured, with simple appendages, is *Cryptostegia madagascariensis*, an older introduction and much more common in Florida than *Cryptostegia grandiflora*, which has larger flowers, only slightly tinged with purple, bifid corolla appendages, and purple-veined leaves. A typographical error, no doubt, is *hinsach* instead of *huisach*, as a vernacular name of *Vachellia farnesiana* (p. 654). The proof-reading generally is good, and the printing, paper and general make-up of the book may be commended. The recording and indexing of large numbers of vernacular names is a valuable feature.

Reference to particular genera or families is made difficult because many of the better known botanical names do not appear, even as synonyms. Not only traditional group names as Labiatae, Cruciferae, Compositae and Leguminosae are discarded, but old and well-known family groups are not to be traced through the index. Of the family Anacardiacae, for example, or even of the genus Anacardium, of which there are a few trees in Florida, nothing is found. By looking for Rhus one locates the Spondiaceae, not as the Cashew Family or the Hog-Plum Family, but as the "Sumac Family." In like manner the Artocarpaceae are not the "Breadfruit Family" as might be expected, but the "Mulberry Family." The Family name Sterculiaceae is replaced by "Buettneriaceae—Chocolate Family," although the cacao tree (Theobroma) does not find a place in the Manual, and chocolate is not the name of the tree in any country where it is grown, but refers to a manufactured product.

The idea that it is possible suddenly to suppress the names that have been used for many years for important genera and higher groups is a serious mistake, from the standpoint of geneticists or others whose interest in plants is not narrowly taxonomic. Though changes of names are necessary, and in the interest of an eventual stability of usage, the observations and experiments that have been recorded under different

names must remain accessible, at least through a period of transition. Too much zeal for immediate suppression of the names that are being replaced may defeat the purpose of reform, as in other cases, by making it seem a virtue to resist an unreasonable demand. Not only the more important synonyms should be carried for a reasonable period, but the authors and dates of the genera and higher groups might well be given, not merely to reflect the fact that botany has a historical development, but to facilitate reference and study of the group characters and relationships.

Books Received

BOOKS are acknowledged in this column as received, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. As far as space permits, books that contain material of special interest to the readers of the JOURNAL *will be reviewed in later numbers.*

WORKING DOGS, *by* ELLIOTT HUMPHREY and LUCIEN WARNER. Foreword by Raymond Pearl. An attempt to produce a strain of German Shepherds which combines working ability and beauty of conformation. Pages, 253, 49 illustrations. Price, $3.50. The Johns Hopkins Press, Baltimore, 1934.

A summary of some phases of the "Seeing Eye" experiment, whose primary purpose was to produce intelligent and emotionally stable dogs to act as guides for the blind. A very important contribution to applied genetics and to comparative psychology.

A DECADE OF PROGRESS IN EUGENICS. Scientific papers of the Third International Congress of Eugenics. Pages, 531, illustrations. Williams & Wilkins Company, Baltimore, 1934.

A bird's eye view of what eugenists and their friends were thinking about in 1932. Abstracts of many of these papers were published in the JOURNAL for October, 1932.

LIVING THINGS. A high school biology, *by* WALLING CORWIN and MAE JOHNSON CORWIN. Pages, 632, and 362 illustrations. P. Blakiston's Son & Co., Inc., Philadelphia, 1934.

When one attempts to cover the entire subject of life in 632 pages it is not surprising that the authors sometimes get a little out of breath. Heredity, as it applies to plants, animals, and man is dealt with in a chapter of fourteen pages. Among other matters considered therein: Burbank, Father Mendel, the U. S. Department of Agriculture, certified sweet potatoes, and the descendants of Elizabeth Tuthill and of Max Jukes. That Mendel's Laws are not hitched to the chromosomes (the chromosomes are not mentioned in this chapter at all) may suggest that the authors are covering too much ground for the good of their prospective readers—students of high school biology.

THE SEXUAL LIFE OF SAVAGES, *by* BRONISLAW MALINOWSKI. Introduction by Havelock Ellis. Pages, 603, 90 illustrations. Price, $3.75. Harcourt, Brace and Company, New York, 1934.

A reissue of Malinowski's monumental work at a reduced price.

PRINCIPLES IN THE TREATMENT OF INFLAMMATION, *by* T. E. HAMMOND. Pages, 209. Price, 10s 6d. H. K. Lewis & Co., Ltd., London, 1934.

The author's concept of inflammation as a contest between the patient and the infective organisms brings the question of constitution directly to the fore. The book is full of interesting case histories, some presented to emphasize the difficulty of evaluating

therapeutic measures when a valid control is so difficult in human material.

SCIENCE IN THE NEW EDUCATION, *by* S. R. SLAVSON and ROBERT K. SPEER. Pages, 390. Price, $2.50. Prentice-Hall, Inc., New York, 1934.

That inculcation of scientific method is not easy is demonstrated by the many plans discussed by the authors. Classes of identical twins might make controlled experiments possible regarding the value of some of these.

PARASITISM AND DISEASE, *by* THEOBALD SMITH. Pages, 196. Princeton University Press, Princeton, 1934.

The discovery by Dr. Theobald Smith in 1893 that Texas fever is transmitted through the tick, not from cow to cow, paved the way for the control of malaria, yellow fever and many human diseases. This book appeared shortly before Dr. Smith's death, December 10. It summarizes the views of a pioneer whose life was devoted to research in this field.

THE JEW IN SCIENCE, *by* LOUIS GERSHENFELD. Pages, 224. Jewish Publication Society of America. Philadelphia, 1934.

SEMITIC AND HAMITIC ORIGINS, Social and Religious, *by* GEORGE AARON BARTON. Pages, 395. University of Pennsylvania Press, 1934.

RACES, NATIONS AND JEWS, *by* JOSEPH TENNENBAUM. Pages, 170. Price, $2.00. Bloch Publishing Company, New York, 1934.

The Nazi business seems to be adumbrating in the printing presses—naturally with no little warmth. The lists of Jewish contributors to science and the scientific arts (medicine, etc.) are calculated to give Herr Goebels a few bad moments.

HANDEDNESS: RIGHT AND LEFT, *by* IRA S. WILE. Pages, 439, bibliography of 50 pages. Price, $2.75. Lothrop, Lee and Shepard Company, Boston, 1934.

The asymmetry mechanism whereby we are right-handed or left-handed is almost as fundamental as sex and we know even less about it. Estimates of the proportion of left-handed individuals in the population range from five to thirty per cent. Opinions as to the causes and effects of left-handedness vary as widely. All of the important ones, along with many other matters dealing with handedness, are discussed in this fascinating book.

THE CASE FOR VOCATIONAL GUIDANCE, *by* ANGUS MACRAE, M. A., M. B. Three lectures given under the Heath Clark bequest to the National Institute of Industrial Psychology. Pages, 92. Price, $1.00. Pitman Publishing Corporation, New York, 1934.

What the British analogues of industrial psychologists are doing to keep round pegs out of square holes.

THE PROBLEM OF MENTAL DISORDER, a study undertaken by the Committee on Psychiatric Investigations of the National Research Council. Pages, 388. Price, $4.00. McGraw-Hill Book Company, Inc., New York, 1934.

Five chapters on the psychiatrical point of view and twenty chapters on the status of associated fields of research, by recognized authorities. Professor H. S. Jennings writes on "general biology and genetics" and Professor G. H. Parker on "origin, plan, and operational modes of the nervous system."

SEX-HYGIENE, *by* ALFRED WORCESTER, A. M., M. D., ScD. What to teach and how to teach it. Pages, 134. Price, $2.50. Charles C. Thomas, Springfield, 1934.

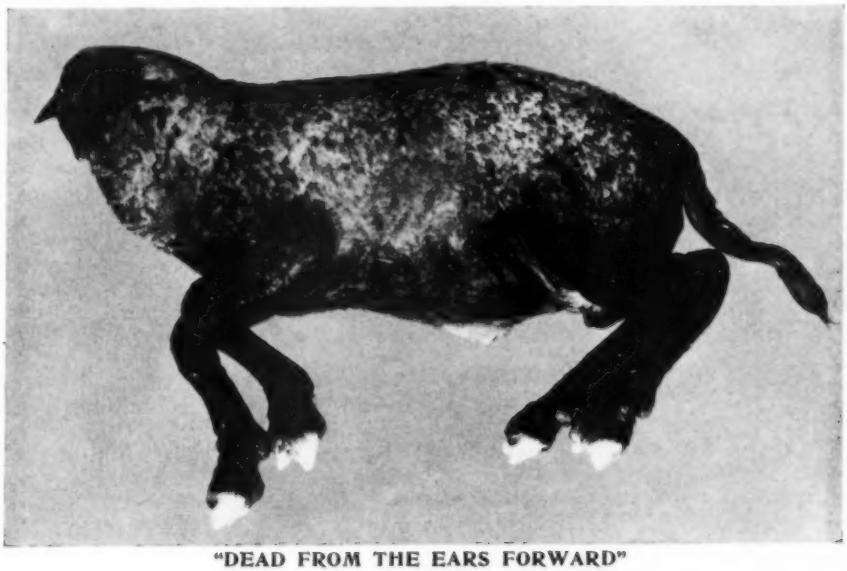
THE STORY OF THE PLANTS, *by* F. MARTIN DUNCAN and L. T. DUNCAN. Pages, 80, illustrations. Oxford University Press.

One of a series of quite highbrow (and this one quite well done) scientific bedtime stories issued by the Oxford University Press under the general title "The Wonders of Nature." This appears to be an old standby, having been issued originally in 1914, and reprinted in 1925, 1928, 1930 and 1933.

A FACELESS LAMB

L. M. WINTERS AND H. C. H. KERNKAMP*

University of Minnesota



"DEAD FROM THE EARS FORWARD"

Figure 9

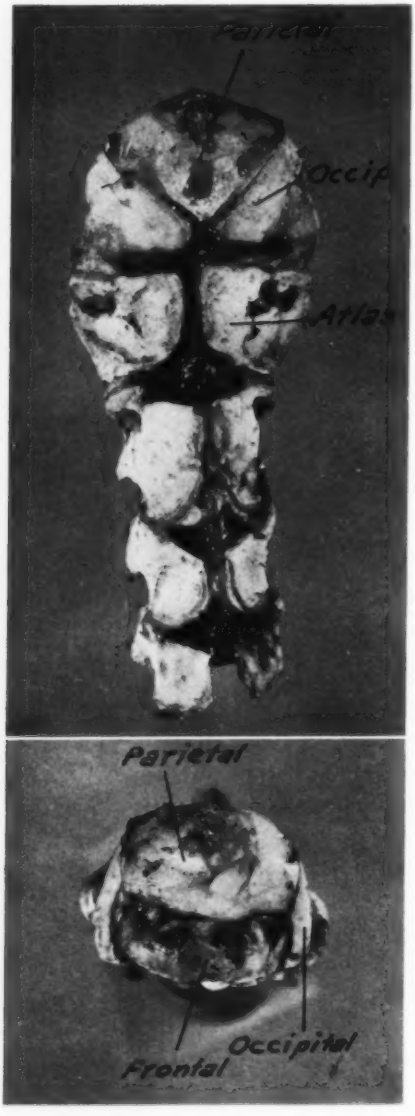
This lamb is normally developed except that the facial parts are entirely lacking. The case is of interest for several reasons. There is enough inbreeding in the pedigree of this lamb to make it possible that recessive factors are involved. Lethal factors have been demonstrated in the guinea pig which produce headless monsters somewhat resembling this and a similar causation may be involved in this case.

A FACELESS lamb, which on casual examination would pass as headless, was born in the University flock at the Southeast Demonstration Farm and Experiment Station. The lamb was furnished us by Mr. Robert Hodgson, superintendent of the station.

This lamb was twinned with a normal lamb which was delivered first. The faceless lamb was well developed, well covered with wool, well muscled, reasonably fat, and on dissection all internal organs appeared normal. The digestive tract was rather distended, being filled with an unusual amount of fluid, but there was no indication that the lamb had suffered any pathologic effects from this source. The hoofs and legs did appear a little underdeveloped. The lamb had no semblance of a mouth, nasal openings, or eyes. The ears were but skin outgrowths, not having any opening or the indication of the ear proper.

The bones of the head and neck are illustrated in Figure 10. Dissection revealed that the occipital, parietal, and frontal bones were present although

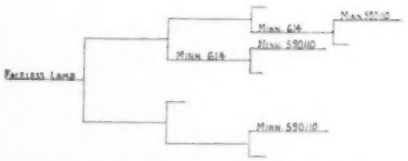
*Members of the Divisions of Animal Husbandry and Veterinary Medicine, respectively. This paper is No. 1266, Minnesota Journal Series, published with the approval of the Dean and Director of the Minnesota Experiment Station.



HEAD BONES OF FACELESS LAMB

Figure 10

The cranial bones are present though badly distorted. The facial bones are entirely lacking.



PEDIGREE OF FACELESS LAMB

Figure 11

While not showing an extreme degree of inbreeding this pedigree gives basis for the suspicion that a recessive gene may be involved in the causation of this condition.

their morphology was greatly distorted. It was the facial bones of the head that were missing; the cranial parts were decidedly vestigial, however. Fasten[1] has previously reported on a headless lamb which appears very similar to this one although no dissection was reported.

The genetic history of this lamb is possibly of significance in that it is inbred slightly. The pedigree is given in Figure 11. This, coupled with the previous case reported by Fasten, is some indication that genetic lethal factors may be the cause of this anomaly. On the other hand, it is somewhat difficult to believe in a hereditary abnormality of this kind. This condition may have arisen from some physical obstruction or constriction such as an amniotic band as illustrated by Jordan and Kindred[2] or an interrupted blood flow.

It is interesting that an individual can develop otherwise so normally with practically no head. Unfortunately the brain was destroyed in the process of preparing the vertebrae and skull for photography; but later dissection revealed a rudimentary brain cavity. It is obvious that the brain was partially developed and that the central nervous system as a whole was sufficiently developed to provide for the proper coordination of development.

Literature Cited

1. Fasten, Nathan, 1932. A headless lamb. *Journal of Heredity*, 23:421.

2. Jordan, H. E., and J. E. Kindred. *A textbook of embryology*. D. Appleton and Co., New York, 1930.

STUDIES ON VARIETAL RESISTANCE OF PINEAPPLE PLANTS

Part II. Plant Resistance to *Heterodera marioni* (Cornu) Goodey*

H. R. HAGAN and J. L. COLLINS†

DIFFERENCES were found in root development of certain varieties of pineapple plants by Collins and Hagan in 1932.‡ The tolerance of each variety to nematode attack was measured by the percentage reduction in root length due to nematode infestation.

This paper is a continuation of our quantitative studies on relative resistance of pineapple varieties, using larger populations of plants. In addition, a report is made of the effect upon development of the aerial portions of the plant caused by nematode infestation of the roots.

One hundred plants each of Cayenne, Lot 520 (Cayenne × Wild Brazil hybrid), Pernambuco, and 50 plants of Wild Brazil were used. One half of the plants of the first three varieties were grown in root observation boxes and one half in soya tubs. The Wild Brazil plants were grown in root observation boxes. In all cases only one plant was grown in a single container. The cubic capacity of a soya tub, approximately five gallons, is about twice that of a root observation box. The composite soil in the containers was a sterilized compost, the same as is used in seedling culture, made from field top soil, 6 parts; manure, 2 parts; and pine waste, 2 parts. The plants were grown in the lathhouse at Wahiawa and all were subject to the same set of environmental conditions.

In the varietal tests previously reported the plants were inoculated with nematode larvae after they had produced roots; but in this test nematode egg masses from cowpea roots were added to the soil either before, or within thirty days after, the plants were placed in the soil. This condition would more nearly approach that which plants would meet when grown in a field infested with nematodes. The inoculated soya tubs each received 500 egg masses, and each of the root boxes received 100 egg masses. Thus the test included for each variety 25 inoculated and 25 check plants for each type of container except Wild Brazil, of which there were 25 inoculated and 25 check plants in root boxes only.

At the age of eight months, the plants were carefully washed free from soil and the following records made:

On Check Plants:

1. Weight of entire plant
2. Weight of leaves
3. Weight of stump
4. Weight of all roots
5. Weight of lateral roots
6. Number of leaves
7. Number of main roots
8. Length of each main root

On Inoculated Plants:

The same records as for the checks and in addition:

9. Number of galls per plant
10. Number of lateral galls per plant.

In addition to the above measurements, photographic records were taken

*Published with the approval of the Director as Technical Paper No. 53 of the Experiment Station of the Association of Hawaiian Pineapple Canners, University of Hawaii.

†Associate Nematologist and Geneticist, collaborators.

‡COLLINS, J. L., and H. R. HAGAN. Nematode Resistance of Pineapples. Varietal resistance of pineapple roots to the nematode *Heterodera radicicola* (Greef) Müller. *Jour. Heredity* 11: 459-465; 503-511. 1932.

of average check plants and average infested plants, so far as this average could be determined by observation.

Upon final examination of the plants many were found to be uninfested with nematodes, or so lightly infested that data taken from them would not be fairly comparable. These were discarded, hence some of the tabulations will show fewer plants in them than mentioned above.

In collecting the data, as outlined, the plants were rendered useless for further experimental work. However, another test, under field conditions, has been installed with a view to supplementing this investigation. It is designed to determine the influence of *Heterodera marioni* on mature pineapple plants, particularly on fruit yield.*

Comparison of Varieties

In making these comparisons we shall first consider only such measurements as were obtained from plants grown in observation boxes, since these containers were used in the first study. Later in the paper comparisons and comments will be made on tub-grown, as contrasted with box-grown, pineapple plants.

The average plant weights of the different varieties together with other data are shown in Table I. The weights obtained are the sums derived from adding root weight, stump weight and leaf weight, in each case. Plant weight serves to present a measure of varietal growth as a whole while the other comparisons treat the different plant parts independently. In the observation boxes Cayenne and Lot 520 exhibit essentially the same weights with 863 ± 14.7 and 883 ± 15.8 grams respectively, Pernambuco distinctly less with 476 ± 15.2 grams, while Wild Brazil weighs approximately one-half as much as the first two or 405 ± 21.8 grams (Figures 12, 13, and 14). This might be considered to be a fairly accurate picture of the relative weights of plants of these varieties, grown under these conditions, since the number of individuals involved is sufficiently large to give averages typical of the varieties.

Stump weight is considerably greater in Cayenne than in the other varieties. Lot 520 stumps weigh slightly less while Pernambuco and Wild Brazil stumps are, comparatively, much lighter in weight. They are, indeed, about one-half as heavy as those of Cayenne. These variations in stump weight express absolute size relationships as well, for the water displacement of all of the stumps, ascertained but not shown in tabular form, is 1 +, the error in reading displacements being so large that the exact specific gravity was not obtained. Stump weight represents about 9 or 10 per cent of the total plant weight for all of the varieties.

Comparisons of Leaves in Check Plants

There is remarkable uniformity in the number of leaves per plant in each variety, as indicated in Table I by the small probable error. This is, perhaps, due to the fact that the leaves already had been formed on the planting material, before it was detached from the mother plant, hence long before being used in this test.

Significant differences between the varieties of plants were found in the number of leaves developed at the age of eight months, Figures 12, 13, and 14. The Lot 520 crowns exceeded the Cayenne slips by 22 ± 1.27 leaves, the Pernambuco slips by 32 ± 1.19 leaves, and the Wild Brazil shoots by 36 ± 1.46 leaves. Cayenne plants had 10 ± 0.78 leaves more than Pernambuco, and 14 ± 1.16 more than Wild Brazil. It cannot be said that a significant difference exists between Pernambuco and Wild Brazil for the leaves of the former were only 4 ± 1.07 greater in number. No attempt has been made to draw con-

*We wish to acknowledge the assistance rendered in obtaining these measurements by Miss M. Gittel, Mr. K. Ishiyama, Mr. H. Kim, Miss J. Oliveira, Dr. von Kesseler and Mr. F. Yap.

clusions regarding varietal differences in number of leaves for most of the comparisons lie between different sorts of planting material, namely, shoots, slips and crowns. These figures are simply a statement of conditions found among the check plants at this time. The difference between Cayenne and Pernambuco appears to be genetic, for here the same type of planting material was grown for both varieties.

The leaf weight in all varieties is approximately 83 per cent of the total plant weight. Since the latter already has been discussed it will be unnecessary to add further comments here since leaf weight and plant weight show parallel variations.

Comparisons of Roots in Check Plants

Comparisons of roots will necessarily be brief since the subject was taken up in detail in an earlier paper. In general, it may be said that the data obtained from this test using larger numbers of plants, confirm the former conclusions. Table II presents information regarding the number, length and weight of roots.

The number of roots per plant is considerably greater than previously given. This we believe is due to the fact that in this, the second test, the roots were removed from the plant before counting and the tabulation included a large number of short axillary roots from beneath the leaf bases. This was not done in our first test because the plants were, in that case, set out in the field for further growth and observation.

Pernambuco has 36 ± 2.2 roots while Cayenne has 60 ± 2.1. Lot 520 with 54 ± 1.5 roots also exceeds Pernambuco but appears to have slightly fewer roots than Cayenne although the difference (6 ± 2.9) is not statistically significant. Wild Brazil has only 12 ± 0.79 main roots compared with 60 ± 2.1 possessed by Cayenne.

Lot 520 roots have an average total length of 1459 ± 37 centimeters which is approximately the same as Cayenne. Pernambuco has a somewhat shorter root system, totalling 853 ± 40 centimeters, while Wild Brazil roots are but 254 ± 17 centimeters in length. These figures are almost the same as given for these varieties in our first paper except that Lot 520 now shows a greater average root length.

The weight of roots is greatest in Lot 520 with an average of 78 ± 3.3 grams. Cayenne closely approaches this figure with 72 ± 3.7 grams, but Pernambuco's root system averages only 27 ± 1.4 grams. The roots of Wild Brazil not only are few in number but their weight, too, is meager, averaging 19 ± 1.6 grams. The fine, fibrous roots on plants are presumed to furnish the absorptive area through the root hairs present on them. Lot 520 and Pernambuco excel in this regard as almost half of the root weight is represented by fibrous roots. Only a third of the total root weight of Cayenne and Wild Brazil is due to the laterals. All the root weights were taken without drying and the amount of water contained in and on them undoubtedly increased the actual figures, but relatively they are comparable. The figures thus obtained are in accord with the conclusions derived from observations on the root systems of the different varieties. Figures 15 and 16 present photographs of the root systems of typical check plants of the different varieties taken at the same distance from the camera.

An increased percentage of fibrous roots is an important asset to a variety since it increases the efficiency of the variety in utilization of the nutrient elements from the soil, and renders less serious the destruction of some of the roots by nematode infestation.

Root Cages and Tubs

So far as conditions could be made uniform, they were alike in the box-grown and tub-grown plants. Two known and two undetermined variables are: (a) approximately twice the

CAYENNE

LOT 520

PERNAMBUCO

CONTROL PLANTS OF THREE VARIETIES

Figure 12

See legend on opposite page.

CAYENNE

LOT 529

PERNAMBUCO

INOCULATED PLANTS

Figure 13

Comparable tub-grown plants of three varieties showing differences at age of eight months in control (uninfested) and in plants infested artificially with cultures of nematode *Heterodera marioni*. Significant differences in growth rate and in number of leaves have been produced by infestation. The cuts were furnished by the Association of Hawaiian Pineapple Canners.

amount of soil per plant in the case of the tub-grown individuals; (b) the tub permitted roots to grow equal distances laterally from the plant in any direction while the roots of the box-grown plants were restricted in lateral growth on two sides; (c) temperature changes in the soil might occur more rapidly, and vary more widely, in the root boxes than in the tubs; (d) soil moisture might change more rapidly in the boxes than in the tubs. In the comparisons made on the following pages the differences shown are ascribed to the container which, of course, includes these variable factors. Table III has been prepared to show comparisons in the development of plants between box-grown and tub-grown individuals in each variety. Check plants which were grown in tubs are compared with check plants which were grown in boxes; inoculated ones grown in tubs are compared with other inoculated plants which were grown in boxes.

It will be seen from consideration of the data in Column 5 of Table III that the number of roots produced is altered by the type of container used and that this effect is not the same for all varieties. Lot 520 check plants suffer a loss of 36.5 per cent in the number of roots when grown in root boxes instead of soya tubs, while Cayenne loses only 18.9 per cent of its root number. This difference between these two varieties may be emphasized in this case because crowns were used to start the Lot 520 plants and slips for the Cayenne plants. Nevertheless, the difference between tub and box-grown plants of all varieties is in the same direction, fewer roots being produced in the root boxes. This phenomenon is common to check and inoculated plants alike.

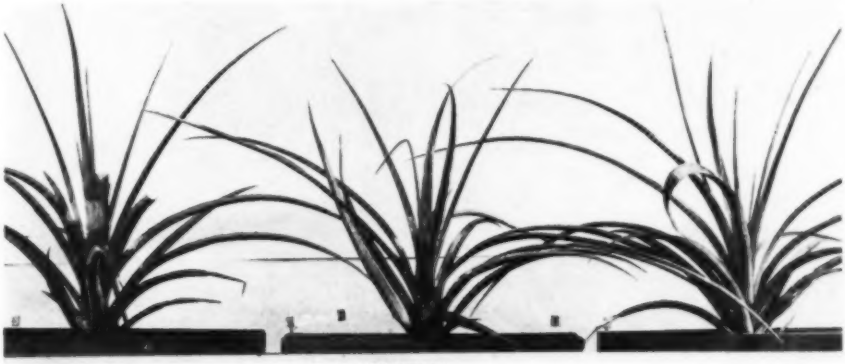
Plant weight and stump weight also are altered in a similar manner while the characters of leaf number, root length and lateral root weight show little or no influence which may be ascribed to the kind of container employed. These differences in development due to the types of container are expressed in percentages in Table IV, which makes direct comparisons of varieties possible.

These comparisons show that experimental plants of different varieties grown under apparently uniform conditions may not result in equally good development of these varieties. The conditions supplied may be sufficient for the normal growth of some varieties and insufficient for others. It has been shown that Lot 520 is under a 50 per cent greater growth handicap in root production in the observation boxes than is Cayenne. The fact that Lot 520 shows a root growth superior to Cayenne, even under such a handicap, serves to emphasize the superior vigor of the Lot 520 plants and to harmonize the results of box-grown Lot 520 plants with observations of the more vigorous growth characteristics of this variety under field conditions. Field grown 520 plants exhibit a more marked superiority of vigor in comparison with Cayenne plants than they have in these two experimental tests. Pernambuco, on the other hand, is under no greater handicap than Cayenne.

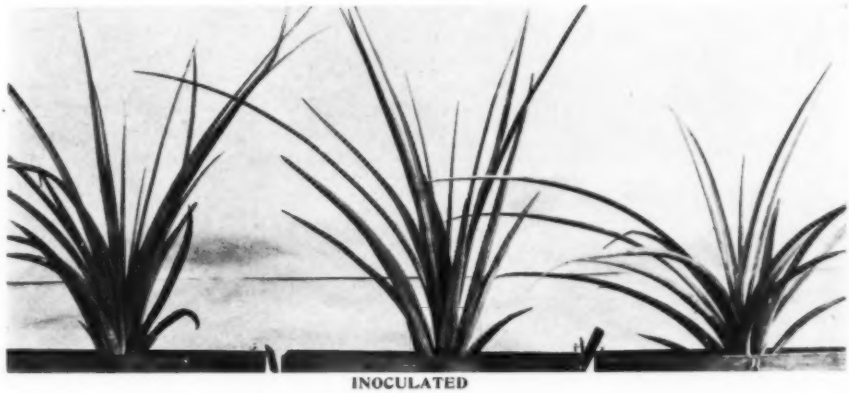
These findings, however, do not necessarily invalidate the use of root observation boxes in work employing different varieties, when such experiments involve the comparison of infested and check plants of the same variety as ours have. Comparisons between different varieties should be checked with field experiments or with plants grown in containers having a larger soil capacity than the root boxes.

Control and Infested Plants Compared

In the foregoing pages we have pointed out certain inherent differences found in four varieties of pineapple check plants in the number and weight of various plant parts. An analysis, too, has been made of box-grown as distinguished from tub-grown individuals in each variety. In this section we will attempt to show the differences between



CONTROL



INOCULATED

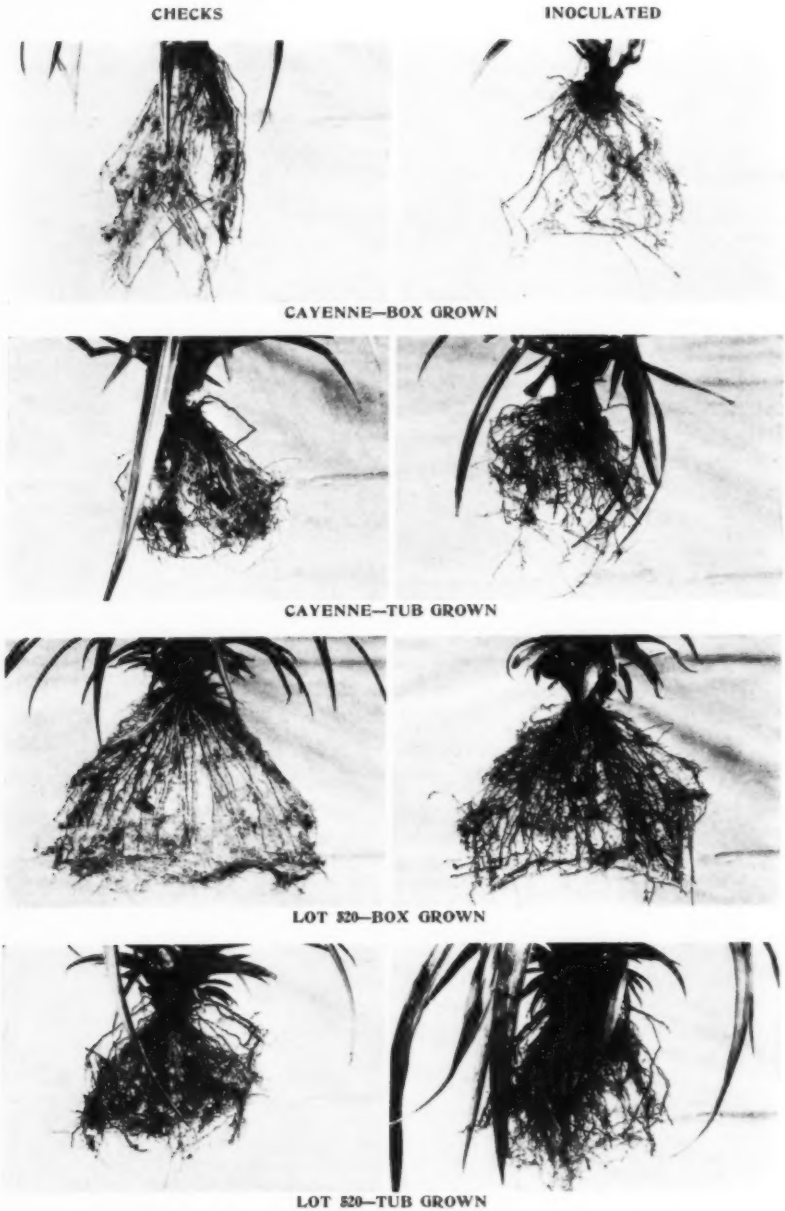
GROWTH OF RESISTANT VARIETY

Figure 14

Box-grown plants of Wild Brazil pineapples, a nematode-resistant variety in which growth was little if any affected by nematode infestation. The photographs in this figure and in Figures 12 and 13 were all made at the same focus, so that all are directly comparable as to size.

check and infested plants which may be ascribed to nematodes.

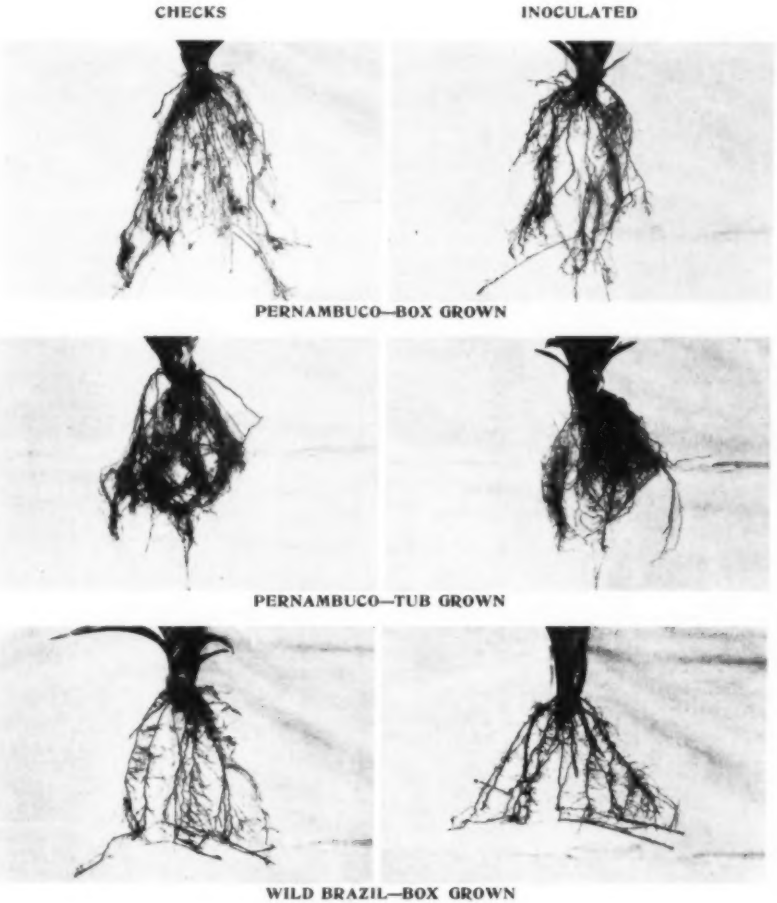
The original data for the measurements of plant parts are recorded in Tables I and II. Table III gives the percentage reduction between check and infested plants for each weight or measurement, which has been calculated from the data in the first two tables. When a significant reduction is not shown, the figures are bracketed. Photographs of plants, typical for each variety and treatment, are shown in Figures 12, 13, and 14, before they were removed from the containers for examination. Root systems of check and infested plants are reproduced in Figures 15 and 16. All plants in the tubs and root cages were photographed at the same distance from the lens, and on the same date. The photographs of root systems were taken at a uniform distance from the lens after they had been washed free from soil for examination.



EFFECTS OF INOCULATION AND ROOT ENVIRONMENT

Figure 15

Check and inoculated plants of two varieties grown in boxes and in tubs. It was found that the root growth of the plants was definitely influenced by the type of receptacle in which they were grown. In some varieties these differences were of a magnitude that overshadowed the effects produced by nematode infestation.



ROOT SYSTEMS OF AVERAGE PLANTS

Figure 16

The varietal differences in reaction of the plants grown in boxes and tubs was a striking feature of these experiments. The differences in the Pernambucco variety due to box or tub culture far transcended the differences due to nematode infestation. Wild Brazil had very few lateral roots either in check or infested plants. Nematode infestation affected it the least.

There is a significant reduction in plant weight due to the presence of nematodes for all varieties except Lot 520 tub-grown and Wild Brazil plants. Cayenne apparently is affected to about the same extent as Pernambuco. Stump weight reduction is evident only in the case of Cayenne tub-grown plants and Lot 520 box-grown plants. As expected, the number of leaves was not influenced because leaf number for the early months of plant growth at least, is largely determined before planting material is collected. Leaf weight, however, is ma-

Table I. Differences in aerial parts between check and inoculated plants of both tub- and box-grown cultures.

Variety	Number of plants 1	Plant weight grams 2	Stump weight grams 3	Leaves Number 4	Leaves Weight grams 5	Leaves % of total plant wt. 6
Cayenne tubs						
Check	25	1290 ± 31.6	152 ± 4.6	49 ± 0.96	1084 ± 26.4	84%
Inoculated	22	913 ± 24.6	119 ± 4.0	45 ± 0.76	746 ± 19.0	81%
Difference		377 ± 41.0	33 ± 6.0	4 ± 1.20	338 ± 32.0	
Cayenne boxes						
Check	24	863 ± 14.7	90 ± 2.0	42 ± 0.64	702 ± 10.8	81%
Inoculated	25	686 ± 15.7	80 ± 3.0	41 ± 0.69	561 ± 31.0	81%
Difference		177 ± 22.0	10 ± 3.6	1 ± --	141 ± 33.0	
Lot 520 tubs						
Check	25	1254 ± 28.0	107 ± 3.3	62 ± 1.10	1031 ± 22.2	82%
Inoculated	7	1073 ± 104.3	84 ± 6.2	58 ± 2.80	868 ± 86.0	81%
Difference		181 ± --	23 ± 6.7	4 ± 3.00	163 ± 88.0	
Lot 520 boxes						
Check	25	863 ± 15.8	72 ± 2.1	64 ± 1.10	729 ± 14.8	82%
Inoculated	11	704 ± 15.4	51 ± 1.8	60 ± 1.10	557 ± 11.8	83%
Difference		179 ± 22.0	21 ± 2.8	4 ± 1.60	147 ± 19.0	
Pernambuco tubs						
Check	25	763 ± 16.0	76 ± 2.4	38 ± 0.47	652 ± 12.7	85%
Inoculated	24	628 ± 16.1	62 ± 3.0	36 ± 0.37	513 ± 12.3	81%
Difference		135 ± 23.0	14 ± 3.8	2 ± 0.59	139 ± 17.0	
Pernambuco boxes						
Check	25	476 ± 15.2	41 ± 3.0	32 ± 0.46	408 ± 11.8	85%
Inoculated	25	356 ± 13.8	31 ± 1.7	30 ± 0.51	312 ± 9.3	87%
Difference		120 ± 21.0	10 ± 3.6	2 ± 0.69	96 ± 15.0	
Wild Brazil boxes						
Check	25	406 ± 21.8	37 ± 2.1	28 ± 0.97	348 ± 18.5	85%
Inoculated	15	432 ± 21.8	41 ± 2.4	29 ± 0.67	375 ± 56.0	86%
Difference		27 ± --	4 ± --	1 ± 1.20	-25 ± 58.0	

Table II. Differences in root systems between check and inoculated plants both tub- and box-grown cultures.

Variety	Roots per plants Number 1	Length centimeters 2	Weight grams 3	Lateral weight grams 4	Galls Total number 5	Number on laterals 6
Cayenne tubs						
Check	74 ± 2.60	1501 ± 45	67 ± 5.3	22 ± 2.80		
Inoculated	83 ± 2.60	1213 ± 44	46 ± 2.3	7 ± 0.60	44 ± 2.80	18 ± 1.80
Difference	9 ± 3.70	288 ± 63	19 ± 5.8	15 ± 2.20		
Cayenne boxes						
Check	80 ± 2.10	1564 ± 30	72 ± 3.7	25 ± 1.50		
Inoculated	72 ± 2.50	1095 ± 41	46 ± 1.7	10 ± 0.50	100 ± 7.80	53 ± 6.40
Difference	12 ± 3.30	469 ± 68	26 ± 4.1	15 ± 1.60		
Lot 520 tubs						
Check	85 ± 6.20	1505 ± 69	117 ± 5.9	42 ± 1.60		
Inoculated	84 ± 6.20	1498 ± 168	122 ± 13.4	37 ± 7.00	36 ± 9.90	15 ± 6.00
Difference	1 ± 8.80	7 ± 181	-- --	5 ± 7.20		
Lot 520 boxes						
Check	54 ± 1.50	1459 ± 37	78 ± 3.3	34 ± 1.90		
Inoculated	55 ± 1.70	1296 ± 59	66 ± 2.4	19 ± 1.60	14 ± 0.75	5 ± 0.57
Difference	1 ± 2.20	163 ± 69	12 ± 4.1	15 ± 2.50		
Pernambuco tubs						
Check	45 ± 1.90	1022 ± 44	43 ± 2.9	15 ± 1.50		
Inoculated	45 ± 1.40	819 ± 35	52 ± 2.8	14 ± 1.30	51 ± 4.90	24 ± 3.20
Difference	-- --	203 ± 56	-- --	1 ± 1.90		
Pernambuco boxes						
Check	36 ± 2.20	853 ± 40	27 ± 1.4	12 ± 0.86		
Inoculated	40 ± 1.50	567 ± 26	21 ± 1.0	6 ± 0.50	40 ± 2.40	19 ± 2.00
Difference	-2 ± 2.60	286 ± 48	6 ± 1.7	6 ± 1.00		
Wild Brazil boxes						
Check	12 ± 0.79	254 ± 17	19 ± 1.6	6 ± 0.70		
Inoculated	19 ± 1.50	333 ± 21	22 ± 2.0	4 ± 0.50	4.7 ± 0.39	1 ± 0.14
Difference	-7 ± 1.70	79 ± 27	-- --	2 ± 0.85		

Table III. Effect of type of container (or soil volume) on development of the different varieties.

Variety	Plant Plant weight grams	Plant Stump weight grams	Leaves Number	Leaves Weight grams	Roots Number	Roots Length centimeters	Roots Lateral roots grams
	1	2	3	4	5	6	7
Cayenne checks							
Tub	1290 ± 31.6	152 ± 5.0	49 ± 0.96	1084 ± 26	74 ± 2.6	1501 ± 45	22 ± 2.80
Box	863 ± 14.7	90 ± 2.0	42 ± 0.64	702 ± 11	80 ± 2.1	1564 ± 30	26 ± 1.80
Difference	427 ± 34.8	62 ± 5.4	7 ± 1.15	382 ± 28	16 ± 3.3	-63 ± 67	-3 ± 2.70
Cayenne inoculated							
Tub	913 ± 24.6	119 ± 4.0	45 ± 0.76	746 ± 19	83 ± 266	1213 ± 44	7 ± 0.60
Box	686 ± 15.8	80 ± 3.0	41 ± 0.69	561 ± 31	72 ± 2.5	1095 ± 41	10 ± 0.50
Difference	227 ± 29.2	39 ± 5.0	4 ± 1.08	185 ± 36	11 ± 3.6	118 ± 60	-3 ± --
Lot 520 checks							
Tub	1254 ± 28.0	107 ± 3.0	62 ± 1.10	1031 ± 22	85 ± 6.2	1505 ± 69	42 ± 1.60
Box	863 ± 15.8	72 ± 2.2	64 ± 1.10	729 ± 15	54 ± 1.5	1459 ± 37	34 ± 1.90
Difference	391 ± 32.1	35 ± 3.7	-2 ± 1.55	302 ± 27	31 ± 6.4	46 ± 78	8 ± 2.48
Lot 520 inoculated							
Tub	1073 ± 104.3	84 ± 6.0	58 ± 2.80	868 ± 86	84 ± 6.2	1498 ± 168	37 ± 7.00
Box	704 ± 15.4	51 ± 2.0	60 ± 1.10	567 ± 12	55 ± 1.7	1296 ± 59	19 ± 1.60
Difference	369 ± 108.0	33 ± 6.3	-2 ± 3.00	301 ± 87	29 ± 6.4	202 ± 176	18 ± 7.18
Pernambuco checks							
Tub	763 ± 16.0	76 ± 2.4	38 ± 0.47	652 ± 13	45 ± 1.9	1022 ± 44	15 ± 1.50
Box	476 ± 15.2	41 ± 3.0	32 ± 0.46	408 ± 12	36 ± 2.2	853 ± 40	12 ± 0.86
Difference	287 ± 22.0	35 ± 3.8	6 ± 0.65	244 ± 18	9 ± 2.9	169 ± 88	3 ± 1.73
Pernambuco inoculated							
Tub	628 ± 16.1	62 ± 3.0	36 ± 0.37	513 ± 12	45 ± 1.4	819 ± 35	14 ± 1.30
Box	356 ± 13.8	31 ± 1.7	30 ± 0.51	312 ± 9	40 ± 1.5	567 ± 26	6 ± 0.50
Difference	272 ± 21.6	31 ± 3.6	6 ± 0.63	201 ± 15	5 ± 2.1	252 ± 44	8 ± 1.40

Table IV. Differences between tub-grown and box-grown plants showing percentage loss in plant parts due to size of container. Differences in weights, number etc. obtained from data given in Tables I and II. Only the percentage values of such differences are shown below. Reductions that are not significant, because of the high degree of variability, are enclosed in brackets.

Variety	Plant Weight 1	Stump Weight 2	Leaves Number 3	Leaves Weight 4	Roots Number 5	Roots Length 6	Roots Weight 7	Roots Laterals Weight 8
Cayenne								
Tub difference	29.2	21.7	(8.1)	31.1	(12.1)	(15.1)	(28.3)	68.1
Box "	20.5	(11.1)	(2.3)	20.0	(20.0)	30.8	36.1	60.0
Lot 520								
Tub "	(14.4)	(21.4)	(6.4)	(13.8)	(1.1)	(0.4)	(0.0)	(11.9)
Box "	20.2	29.1	(6.2)	19.4	(1.8)	(11.1)	(15.3)	44.1
Pernambuco								
Tub "	17.6	(18.4)	(5.2)	21.3	(0.0)	(19.8)	(0.0)	(6.6)
Box "	25.2	(24.3	(6.2)	23.5	(0.0)	33.5	(22.2)	50.0
Wild Brazil								
Box "	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(33.3)

terially reduced by nematodes and differences are shown for all except Lot 520 tub and Wild Brazil plants. Root number is unaffected, which bears out the evidence given in our first report on eight varieties of pineapples.

The length of the main roots is reduced by significant percentages only in the Cayenne and Pernambuco box-grown plants. At first thought this would seem to indicate that nematodes do not reduce root length and these results appear to conflict with the results found in the first report. But this is not actually the case and the data are capable of an obvious explanation from the figures given in the two reports. First, the root measurements taken in this test include all roots, even those beneath the bases of the leaves which could not be reached by nematodes. This gives more nematode-free roots for all inoculated plants. Second, the nematode galls on plants in the first test were located very largely on the main roots and on the larger laterals. Practically none occurred on fibrous roots. In the second test almost half of the galls were on lateral and fibrous roots as may be seen by referring again to Table II, Columns 5 and 6. Column 5 gives the number of all galls per plant while Column 6 lists only those on lateral and fibrous roots. In Column 5 the non-terminal galls on main and lateral roots are included. Had they been segregated the lateral and fibrous root infestation would have been proportionately higher. As a result of the difference found in the location of galls in these two tests, we would expect to find more damage in main root length in the first test and a greater proportionate loss in lateral and fibrous roots in the second. Finally, the variation between plants is quite high in most cases in this test, hence root reduction in length must be very great in order to approach reliable average figures. It will be noted, moreover, that the difference between check and infested plants in root length is in the same direction in every case except for Wild Brazil. This is the result of some one factor (in this case, nematodes) causing variation constantly in a given direction (Table II, Column 2; Table V, Column 6), notwithstanding the fact that some differences are not statistically significant.

One other point might here be considered in relation to Lot 520 plants. This variety is really a hybrid between Wild Brazil and Cayenne varieties. As Cayenne itself is known to contain many characters for which it is heterozygous, it is obvious that its hybrid offspring would vary exceedingly in the characters received from this parent. This was quite evident in observations made on the growing plants for their size alone showed much divergence. See Figure 12 (center), and Figure 13 (center). Thus we have in Lot 520 a considerable genetic variability superimposed upon environmentally induced variation. The other varieties are clons and do not exhibit genetic variation. Again, the infested plants were relatively few in number and only 18 showed infestation where 50 were expected.

The abundance and weight of lateral and fibrous roots were greatly curtailed in the infested plants, Figures 15 and 16. The percentage reduction is given in Table V, Column 8. Cayenne suffered the greatest loss in a weight reduction of 60-68 per cent of its fibrous root system. The seven plants in Lot 520 boxes lost 44 per cent of their fibrous roots while Pernambuco plants lost 50 per cent. Wild Brazil had very few

Table V. Difference between check and inoculated plants, expressed as percentage reduction of plant parts due to nematodes. These percentages have been determined from the data in Tables I and II.

Variety	Plant Height	Stump Height	Leaves Number	Leaves Weight	Roots Number	Roots Length	Roots Weight	Roots Lateral Weight
	1	2	3	4	5	6	7	8
Cayenne								
Check	33.1	40.7	14.2	35.2	10.9	0.0	0.0	0.0
Inoculated	24.0	32.7	(0.0)	24.7	(13.2)	(9.7)	(4.1)	0.0
Lot 520								
Check	29.9	32.7	0.0	28.0	26.6	(3.0)	(22.5)	(13.0)
Inoculated	(24.3)	29.2	0.0	(32.3)	24.5	(13.4)	(45.9)	(40.6)
Pernambuco								
Check	37.0	46.0	15.7	37.4	(20.0)	(16.8)	(37.8)	(20.0)
Inoculated	43.3	50.0	16.6	38.1	(12.1)	(30.7)	(69.6)	89.1
Wild Brazil boxes								
Check	13	+0.79	17	254				
Inoculated	19	1.50	21	333				
Difference	-7	1.70	-4	-79				

roots and these were scantily furnished with laterals in checks as well as in infested plants. The difference between the weight of fibrous roots of check and infested plants of this variety is only 2.3 times the probable error of the difference and therefore may not be considered to be a difference induced by nematodes. Hence the 33 per cent reduction indicated in Table V, Column 8 is without significance as are the other differences inclosed in parenthesis in this table.

Summary

1. Cayenne, Lot 520 (F_1 hybrid of Cayenne × Wild Brazil), Pernambuco, and Wild Brazil have been tested for resistance of plant parts to attack by the nematode *Heterodera marioni* (Cornu) Goodey. Comparisons were made between check plants grown in root observation boxes and in soya tubs; also between check and infested plants grown in similar containers. The first three varieties have previously been reported upon for root development in relation to nematodes and this portion of the report is a retest of these varieties. Wild Brazil has not been tested before.

2. About 50 per cent of the nematode galls were found on lateral and fibrous roots.

3. Ranked in order of resistance or tolerance to nematode attack the varieties are listed as follows, the most tolerant appearing first; Wild Brazil, Lot 520, Pernambuco, and Cayenne. The last is the variety commercially grown in the Hawaiian Islands.

4. The average number of roots per plant is not influenced in any case by nematode infestation. The average length of roots is reduced in Cayenne and Pernambuco, but not in Lot 520 or Wild Brazil.

5. The number of leaves per plant is found to be the same for both check and infested plants. It is probable that all the leaves present on these young plants were differentiated before this test was started, and hence, were not subject to influences resulting from nematode infestation of roots subsequently developed.

6. The weight of leaves (about 83 per cent of total plant weight), stumps, and of fibrous roots is adversely influenced by nematode infestation, but to a different extent in the different varieties. Cayenne suffered greater injury in all cases than the other varieties, with Pernambuco second, and Lot 520 third, while Wild Brazil appears highly resistant, or almost immune, to the effect of nematode attack.

7. The duplicate series of plants, grown in soya tubs, may be expected to produce larger plants due to the greater volume of soil available to the roots, and this expectation is realized. From a comparison of tub with box-grown plants of the same variety it is found that the different varieties do not respond equally to the same increase in quantity of soil. The number of roots per plant, a character not altered by nematode attack, is greater when the plants are grown in tubs. The difference in Lot 520 plants grown in the two types of containers is 50 per cent greater than in the case of Cayenne or Pernambuco. Thus, it appears that Lot 520 is under a greater handicap, when grown in root boxes, than are the other varieties. Part of this difference might, however, be due to the use of crowns for Lot 520 planting material, and of slips for Cayenne and Pernambuco.

A Glossary Of Technical Terms

Used In This Issue

GENETICS has developed so rapidly that many terms in common use in genetic literature are not yet incorporated in the dictionaries. Many people who are interested in heredity are bothered by such words, for which no definition can conveniently be found. For this reason, it is proposed to publish occasionally a glossary of terms which would not be readily understood and which are not to be found except in new unabridged dictionaries. It is realized that these definitions will probably not meet with universal approval and comments and suggestions will be welcomed.

ALLELOMORPH—Mendelian characters are inherited in alternative series. These alternative genes are called allelomorphs. Examples: Albinism (recessive), Hornlessness (dominant).

AUTOSOME—Any chromosome except the sex-chromosome.

CHIMERA—An organism made up of tissues of different genetic constitutions.

CHROMOMERE—One of the chromatin granules composing the chromosome.

GAMETE—A reproductive cell of either sex; sperm or ovum in animals, pollen grain or ovule in plants.

GONAD—A reproductive gland, or group of glands; an overy, testis or hermaphrodite gland.

GYNANDROMORPH—An individual of which one side (or part) of the body is female in constitution, and the other side (or the remaining part) is male.

HETEROSYNAPSIS — Synapsis between unlike chromosomes.

HOMEOSYNAPSIS—Synapsis between like chromosomes.

HYPERTROPHIC — Unduly and excessively grown.

LINKAGE—Association of genes in inheritance, due to the fact that they are in the same chromosome.

MEIOSIS—The reduction divisions preceding the formation of gametes, in which the chromosome pairs separate, and the chromosome number in the resulting daughter cells is reduced to half the somatic number. (As distinguished from ordinary cell division, *mitosis*) in which each chromosome splits longitudinally to furnish a full complement of (paired) chromosomes to each of the daughter cells.

MITOSIS—Indirect nuclear division involving the formation of a spindle, conversion of the chromatin into threads (spireme), and longitudinal splitting of the threads.

MOSAIC—An organism part of which is made up of tissue genetically different from the remaining part. Mosaics are produced by mutations during development or by chromosome non-disjunction.

MUTATION—Where a heritable variation begins. A sudden variation in an inherited character.

NON-DISJUNCTION — Failure of a pair of chromosomes to separate at meiosis (or of a dividing chromosome to separate in ordinary cell division), so that both members of a pair are carried to one daughter cell, and none to the other.

OÖCYTE—A female germ cell subsequent to the initiation of oögenesis and prior to the second division. An oöcyte is designated *primary* during the growth period and prior to the first division; *secondary* after the first division and before the second.

OÖGONIUM—One of the early germ cells of a female animal, prior to the beginning of oögenesis.

PARTHENOGENESIS—The development of a new individual from a germ cell without fertilization.

SEX-LINKED—Applied to characters carried on the sex-chromosomes—characterized by typical peculiarities in inheritance as a result of this fact.

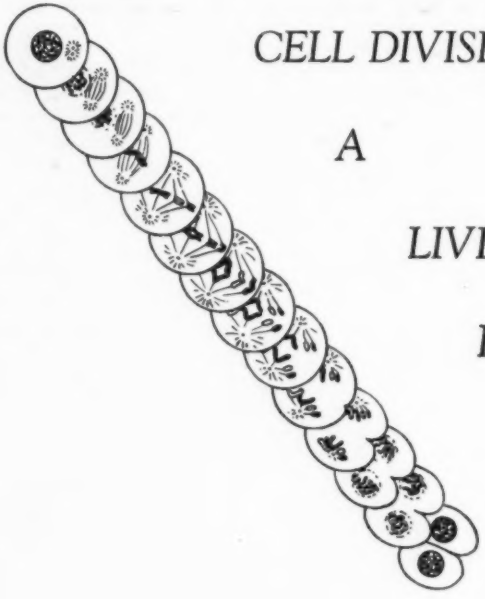
SEGREGATION — Separation of allelomorphic genes at meiosis.

SPERMATOGONIA—Primitive male germ cells.

SOMATIC—Referring to body tissues; having two sets of chromosomes, one set from the female parent and one from the male, as contrasted with germ cells having a single set of chromosomes.

ZOOSPORES—Spores possessing the power of independent motion.

ZYGOTE—An organism produced by the union of two germ cells.



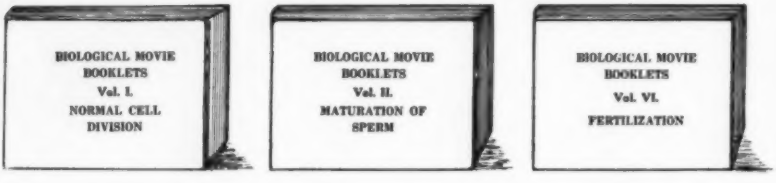
CELL DIVISION

A

LIVING

PROCESS

The fixed cell viewed under the microscope is a dead cell. "Prophase," "Metaphase," and "Telophase" are descriptions not of static conditions but are really fleeting glimpses of a continuous process whose essence is change and movement. The Biological Movie Booklets "bring to life" through a simple application of the "movie" principle in booklet form three important vital processes involving cell division:



THE BIOLOGICAL MOVIE BOOKLETS

DRAWN BY

DR. CLYDE E. KEELER

The set of three booklets—$1.50

(Separately Vol. I—50c, Vol. II—60c, and Vol. VI—70c.)

Can be obtained only from

AMERICAN GENETIC ASSOCIATION

VICTOR BUILDING **WASHINGTON, D. C.**